Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	WC Docket No.: 13-39
Rural Call Completion	)	
Verizon	)	File No.: EB-IHD-14-00014821
	)	Acct. No.: 201532080007
	)	FRN: 0004335592

VERIZON'S PUBLIC REPORT

Pursuant to § 18(b)[4] of the Consent Decree in the above-referenced proceeding, MCI Communications Services, Inc. d/b/a Verizon Business Services ("Verizon") hereby submits the attached report summarizing its investigations, lessons learned, and other information regarding avoidance, investigation, and resolution of rural call completion issues, including information presented in the industry workshop Verizon conducted on rural call completion in Washington, DC on March 29, 2017. Verizon has shared drafts of the report with the Enforcement Bureau and worked with Bureau staff to prepare this final public version following the termination date of the Consent Decree.

Respectfully submitted,

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June 4, 2018

verizon

Rural Call Completion Report

Investigations, Lessons Learned, and Other Information Regarding Avoidance, Investigation, and Resolution of Rural Call Completion Issues

FCC File No.: EB-IHD-14-00014821

June 4, 2018

Introduction

On January 26, 2015, the Enforcement Bureau of the Federal Communications Commission ("FCC" or "Commission") entered into a consent decree ("Consent Decree") with Verizon to resolve and terminate the Bureau's investigation into whether Verizon violated Sections 201(b) and 202(a) of the Communications Act of 1934, as amended, in connection with delivery of long distance calls to certain rural areas. *See*, Consent Decree (attached as Exhibit A).[1] Verizon maintained that its network and call completion practices did not result in any call completion problems. But the company agreed to enter into a Consent Decree to resolve the matter, paying a fine of $2 million and implementing a compliance plan in which it committed to spend $3 million over the subsequent three years to improve call completion to rural areas across the country.

Verizon also agreed under the Consent Decree to:

- Appoint a Rural Call Completion Ombudsman within Verizon to centralize analysis of rural call completion problems;
- Develop a system to automatically identify customer complaints that may be related to rural call completion issues;
- Limit its use of intermediate providers, *i.e.*, telecommunications providers between the Verizon network and the local rural provider;
- Monitor its call answer rates to individual rural areas and conduct an investigation when rates to a particular area fell below a set threshold in any month;
- Host industry workshops and sponsor an academic study on methods to detect and resolve rural call completion problems;
- Provide quarterly summaries of its investigations to the FCC and meet periodically with Commission staff to identify lessons learned; and
- Prepare a report to be publicly filed with the Commission at the end of the three-year compliance period.

The Consent Decree and compliance period expired on January 26, 2018. This Report is intended to satisfy Verizon's obligation to publicly file a report with the Commission at the end of that period. *See,* Consent Decree § 18(b)[4].[2] The Report summarizes Verizon's investigations, lessons learned, and other information regarding avoidance, investigation, and resolution of rural call completion issues, including information presented at Verizon's second industry workshop on rural call completion, held in Washington, DC, on March 29, 2017 ("Workshop II").

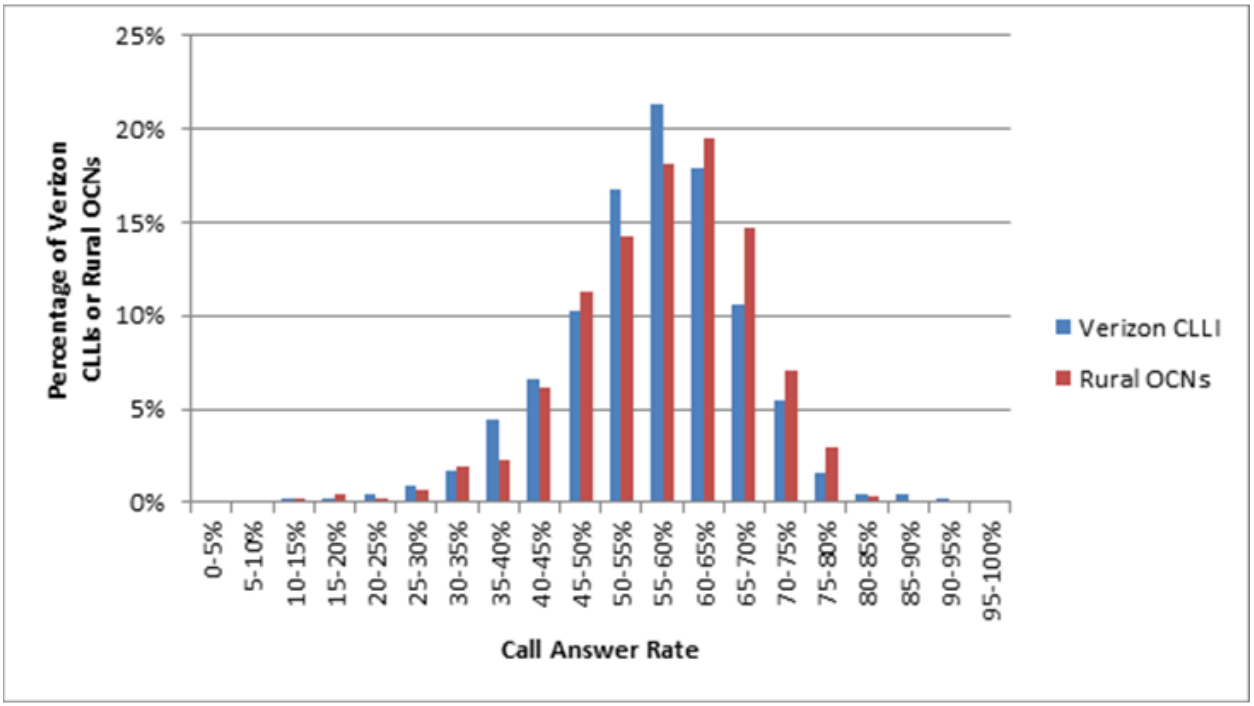
[1] The Consent Decree was entered into with MCI Communications Services, Inc. d/b/a Verizon Business Services ("Verizon" or "Verizon Business") and resolved and terminated the Bureau's investigation with respect to the regulated wholly-owned subsidiaries of Verizon Communications Inc., including Verizon Business, Cellco Partnership d/b/a Verizon Wireless ("Verizon Wireless"), and all affiliated incumbent local exchange carriers ("Verizon ILECs"). Unless otherwise specified, capitalized terms used herein shall have the meaning ascribed to them in the Consent Decree.

[2] On May 2, 2018, Verizon and the Bureau agreed to extend the deadline for filing the public report until June 4, 2018.

Executive Summary

Pursuant to the Consent Decree Verizon spent three years investigating and testing different tools to identify key drivers of call completion issues in rural areas. Among other things, Verizon: (1) investigated hundreds of low "call answer" rates in certain areas; (2) spent $3 million (in addition to the original fine) on these and other efforts; (3) funded an 18-month independent academic research study; and (4) investigated dozens of rural call completion complaints. There are several important conclusions from these efforts (see below). Overall, however, it is clear that call answer rates for various destinations, by themselves, are not a valid basis for drawing conclusions about relative performance to those destinations without much more refinement and analysis. Call answer rates vary for a wide variety of reasons, including carrier signaling practices and a host of end-user behaviors, such as calls by auto-dialers to unassigned numbers, mass calling events, and – particularly in areas with lower call volumes – even calling patterns between a single pair of numbers.

From the outset, Verizon posited that other factors – unrelated to network performance – may contribute to the variability in call answer rates across destinations. For example, early on, Verizon calculated call answer rates for long distance calls that it terminated from its long distance network to 1,391 unique combinations of state/operating carrier numbers ("OCNs") and to 2,824 Verizon-owned switches, and then graphed the distribution of those call answer rates. The results showing answer rate frequency were as follows:



The data suggested, and Verizon's investigative activity under the Consent Decree confirms, that variance in call answer rates is normal. Some destinations simply have normal call answer rates that are higher than normal call answer rates in other destinations.

However, the goals of Verizon's activity under the Consent Decree ultimately went beyond call answer rates. Foremost, Verizon sought to confirm that its network and routing practices were not a persistent cause of call completion issues to rural areas. And Verizon, in fact, did not identify any instance where Verizon's network or routing practices were the cause of such issues. Second, and equally as important, Verizon sought to develop more efficient ways to use data to detect call completion issues, and then to refine its practices for investigating and remediating such issues. In this regard, the primary findings described in this Report are as follows.

- Metrics-based investigation programs should be calibrated to identify persistent or recurring issues. The volume of calls on the public switched telephone network ("PSTN") combined with the frequency with which episodic issues — such as fiber cuts, equipment outages, end user calling campaigns — affect metrics drives the need for efficiency so that investigating resources are not exhausted and are properly focused on remediating systemic and recurring problems.

- Metrics-based programs should focus on variations over time, or variations in performance between different routes/vendors, for a single, common destination. There is too much variability across different destinations to support the efficient use of metrics-based programs on a cross-destination comparative basis.

- Eliminating calls by auto-dialers and calls to unassigned numbers can increase the efficiency of metrics-based investigations.

- There are significant efficiency benefits from having rural call completion complaints investigated by a dedicated team of trained individuals.

- Investigation of actual complaints with robust carrier-to-carrier and end-user engagement in the trouble-shooting process is one of the most efficient ways to identify and remediate rural call completion issues.

Verizon hopes that these and the other findings detailed in this Report will prove useful to the Commission and to other providers as they seek to avoid, identify, investigate, and remediate call completion issues.

Organization of this Report

The Report is divided into the following sections.

Section I: Investigations

Section II: Other Information Regarding Avoidance, Investigation, and Resolution of Rural Call Completion Issues.

Section III: Lessons Learned

This Report includes the following exhibits, which contain more detailed information on various topics and supporting documentation.

Exhibit A: Consent Decree
Exhibit B: Rural Call Completion, Industry Workshop I, April 22, 2015
Exhibit C: Academic Research Paper
Exhibit D: Rural Call Completion, Industry Workshop II, March 29, 2017

The Report also cites material from the Intercarrier Call Completion/Call Termination Handbook published by the Alliance for Telecommunications Industry Solutions (ATIS) (ATIS-0300106, available online at https://www.atis.org/docstore/product.aspx?id=26780).

* * *

I. Investigations

Verizon agreed under the Consent Decree to conduct proactive investigations of potential rural call completion issues based on metrics. Verizon conducted investigations based on two different metrics—Call Answer Rate and the Repeat Attempts Metric (a new metric developed by Verizon and the FCC Enforcement Bureau). Verizon was also required to investigate complaints regarding rural call completion issues, and undertook certain additional investigative activity.

When either metric tripped a certain threshold, as described below, or Verizon received a complaint or otherwise was prompted to undertake an investigation, Verizon would take one or more of the following steps, depending on the scope and nature of information observed and identified during the course of the investigation:

- Contact the rural LEC, tandem provider, and/or Intermediate Provider;[3]
- Perform milliwatt testing;
- Place manual test calls, including to previously unanswered numbers, utilizing SS7 call trace equipment to monitor the exchange of signaling information in real time and to confirm signaling messages were coming from the rural LEC or a tandem provider and not an Intermediate Provider;
- Review routing arrangements, trunk capacity, and network translations;
- Consult with Verizon's fraud group to analyze traffic patterns that may reflect potential call re-origination or other fraudulent behavior;
- Review by Verizon network engineering personnel of call detail records, release cause codes, or other traffic data for the OCN, or switch and trunk data for the Verizon network; and
- Inquire whether other factors (*e.g.*, prevalence of lines with answering technology such as voicemail, or auto-dialer traffic, or relative proportion of unassigned numbers) are relevant.

The scope, process, and results of Verizon's various investigations are described below.

A. Investigations Based on Call Answer Rate

On a monthly basis, Verizon investigated its call delivery to up to 20 rural destinations for which its Call Answer Rate fell below 80% of its Aggregate Rural Answer Rate in the prior month.[4] In addition, as part

[3] Intermediate Provider has the meaning provided in Section 64.1600(f) of the Rules, but excludes a tandem provider to which the terminating provider subtends or a carrier to which the terminating provider requires an indirectly interconnecting carrier to deliver traffic.

[4] Rural destinations were identified by an industry identifier, operating carrier number (OCN). Call Answer Rate means a rate calculated by dividing (1) total Answered Calls by (2) total Attempted Calls minus Attempted Calls to unassigned numbers as indicated by the release cause code (*e.g.*, a release cause code of 1 for calls signaled with SS7 or the corresponding release cause code for calls signaled with session initiation protocol). Answered Call means a call that receives an answer message and a normal release cause code (*e.g.*, a release cause code of 16 or 31 for calls signaled with SS7 or the corresponding normal release codes for calls signaled with session initiation protocol (SIP)). Attempted Call means a call that results in transmission by Verizon toward an incumbent rural local exchange carrier of the initial call setup message, regardless of the voice call signaling and transmission

of the 20 monthly investigations, Verizon investigated up to 10 Rural OCNs that exhibited a sharp, material decrease in Call Answer Rate from prior measurements over a short interval.[5]

From April 2015 to December 2015, Verizon performed 202 investigations. Of those, 176 were investigations into low Call Answer Rate and 26 were investigations into Negative Spikes in Call Answer Rate.

Signaling Practices	***OCNs***	***%***
Cause Code 1 in ACM	30	
Unexpected RWC	83	
EO Non-SS7	22	
		77%
Calling Patterns		
Autodialer	11	
Mass Call	7	
Single number	2	
		11%
Other		
Translations	1	
Verizon Network	1	
No Issue Found	8	
Misc	1	
End Office outage/isolation	10	
		12%
Total	176	100%

Call Answer Rate Investigation Results

technology used. Aggregate Rural Answer Rate means the Call Answer Rate for calls to all Rural OCNs. Rural OCN means an OCN that is designated as rural on the annually updated list published by the National Exchange Carrier Association (NECA), as described in the Rural Call Completion Order, 28 FCC Rcd at 16187, para. 73.

[5] This was referred to as the "Negative Spike" metric, and was triggered when any Rural OCN exhibited an Answer Rate that was one third or less of its 35-day rolling average Answer Rate for two consecutive days.

Outage/SS7 Isolation in RLEC Network	7
Autodialer Event	6
Mass Call Event	5
Single Number Issue	5
End Office not SS7	1
Incorrect Release Message	1
No Issue Found	1
Total	26

Negative Spike Investigation Results

B. Investigations Based on Repeat Attempts Metric

Under the Consent Decree, after six months of investigations were complete, Verizon or the Enforcement Bureau could propose changes to the metrics or triggers used to identify Rural OCNs for investigation. Accordingly, in early 2016, the Bureau and Verizon agreed that Verizon could suspend proactive metrics-based investigations into low Call Answer Rates while the Bureau and Verizon discussed an alternative metric.

During the first part of 2016, Verizon and the Bureau developed a new metric, the Repeat Attempts Metric ("RAM").

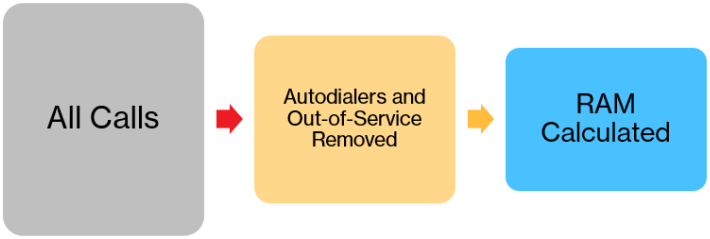
RAM tries to identify repeated efforts to establish or maintain a connection between the same two phone numbers. A repeated attempt is an instance of three or more calls (call attempts and completed calls) between the same two phone numbers occurring in any five minute time period. The number of repeat attempt calls is the total number of calls made during all repeated attempts. RAM is calculated by dividing the number of repeat attempt calls by the total number of calls in the data set. This produces a percentage measure of the number of call attempts that were part of a repeat attempt instance. A high RAM percentage reflects a large number of calls that were part of a repeated attempt pattern, which potentially could indicate some level of difficulty in establishing or maintaining a connection.

In order to further refine RAM, Verizon and the Bureau also agreed on a methodology to try to eliminate from the data set calls from auto-dialers and calls to unassigned (not in service) numbers. A number was deemed to have been in use by an auto-dialer if it made greater than 60 calls during any one minute period during the prior 90 days. This definition was likely both over-inclusive and under-inclusive. For example, large government or enterprise offices with phone systems configured to send a single common caller ID number on out-bound calls could have generated 60 or more calls in a single minute at some point over a 90-day period simply due to the sheer volume of employees making outbound calls from that location. Similarly, auto-dialers configured to send calls at a slower rate—e.g., 30 per minute—would not have been excluded from the data set by this definition. In addition, some auto-dialers place calls from multiple numbers and thus might not have been identified.

An out of service number was deemed to be any called number in the data set that was not observed to have answered any call during the prior 90-day period. Calls answered by voicemail platforms and

answering machines typically show as answered calls in the call data set, so this requirement did not require calls to have been answered by a person.

In sum, RAM is an attempt to perform metrics-based analysis of a data set that includes only calls to in-service numbers that are not from an auto-dialer.



In addition to using a new metric, the RAM-based investigations calculated RAM on a per-CLLI code level, not at the level of an entire OCN.[6]

Verizon's investigations using RAM looked for instances where RAM spiked above 20%. The RAM studies were done using manual data processing methods, and used a relatively small data set that was not statistically validated.

C. *Investigations Based on Complaints*

In order to efficiently respond to complaints regarding rural call completion, Verizon identified subject-matter experts in various departments across the company, and trained them in what was required and expected in the context of investigating rural call completion complaints. Verizon also established a dedicated toll-free number, staffed with persons trained regarding rural call completion issues, to serve as an in-take point for complaints from other providers. Finally, Verizon enhanced its internal systems for customer complaint intake and handling to automatically flag issues related to rural call completion by comparing the NPA-NXX of the "dialed from" and "dialed to" number fields in the complaint to the LERG database. Complaints involving a rural number in either field are handled through a process designed to include consideration of potential rural call completion issues.

D. Other Investigative Activity

In addition to investigating issues associated with the above-referenced metrics and complaints, Verizon also conducted investigations into potential call re-origination and SIM-box fraud at the request of the Enforcement Bureau, and into potential calling party number manipulation on its own initiative.

1. Investigations Regarding Potential Call Re-origination

[6] A CLLI code is a Common Language Location Identifier, and in the context of the RAM studies, represented a wire center or central office—a building that housed network equipment (typically, the switch) of the terminating provider. Operating Carrier Number (OCN) is an identifier for a provider, and a single provider with a single OCN may have multiple CLLIs associated with it.

In layman's terms, re-origination involves placing a second call as part of the process of trying to complete a call, and bridging the two calls together, rather than signaling the originating call through to the terminating provider. For example, an intermediate provider may receive signaling information for a call attempt, and instead of passing that signaling information through to the terminating provider, the intermediate provider may initiate a new call to the called number. This has a number of potential impacts. First, the called party may see an incorrect caller ID. The called party may receive the calling party number associated with the service that the intermediate provider used to initiate the new call, rather than the calling party number of the actual caller.[7] This may also affect the rating of the call. Second, the re-originating party has the ability to disguise the nature of the call. By placing the new call over a wireless device, the re-originating party can make the call appear to be from a wireless caller, or from a different geographic area.[8]

Re-origination is not limited to wireless services; there are flat-rated wireline voice services available to consumer and business customers that can be leveraged as part of a re-origination scheme.

The hypothesis behind Verizon's investigation into re-origination was that certain Verizon flat-rated wireline voice products were potentially being used to re-originate calls into the Verizon network. Notably, this was not an instance of Verizon investigating its intermediate providers (providers to whom Verizon might deliver a call for transport and termination). Rather, this investigation involved reviewing Verizon customer activity to look for potentially anomalous patterns of calls originating on the Verizon network.

Verizon conducted a one-time proof-of-concept study of call records for its Fios Digital Voice residential calling service, its Business Digital Voice service (for small business customers), and its Virtual Communications Express service (for medium business customers). In each instance, Verizon was looking for customer lines being used to originate large volumes of calls with significant minutes of use to rural OCNs. Verizon did not identify any instances of re-origination in that study.

2. <u>Investigations Regarding Potential SIM-Box Fraud</u>

SIM-box fraud is an example of using wireless services for re-origination. In SIM-box fraud, the perpetrator obtains a number of phones from a wireless provider, and then uses the SIM cards (Subscriber Identity Modules) in an array (a box) to re-originate calls. When done using flat-rated wireless calling plans, SIM-box fraud can enable the perpetrator to charge its carrier customers on a per-minute-of-use basis, while paying flat-rated monthly fees at retail for the wireless services used to terminate those calls to the called parties.

The hypothesis behind Verizon's investigations into SIM-box fraud was that SIM-boxes were potentially being used to re-originate calls into the Verizon Wireless network. Notably, this was not an instance of Verizon investigating its intermediate providers (providers to whom Verizon might deliver a call for

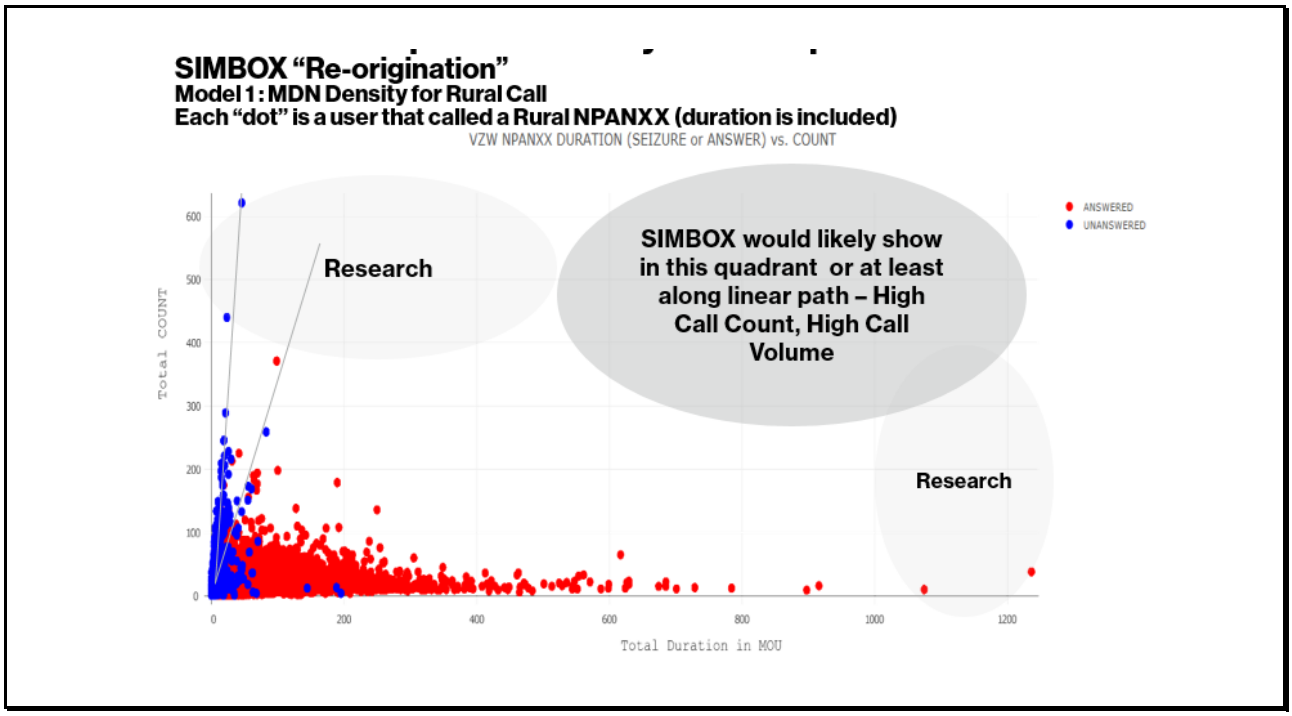
[7] Intercarrier Call Completion/Call Termination Handbook, Alliance for Telecommunications Industry Solutions (ATIS), ATIS-0300106, § 5.1.1.2 ("ATIS Handbook").

[8] ATIS Handbook at § 5.4.3.

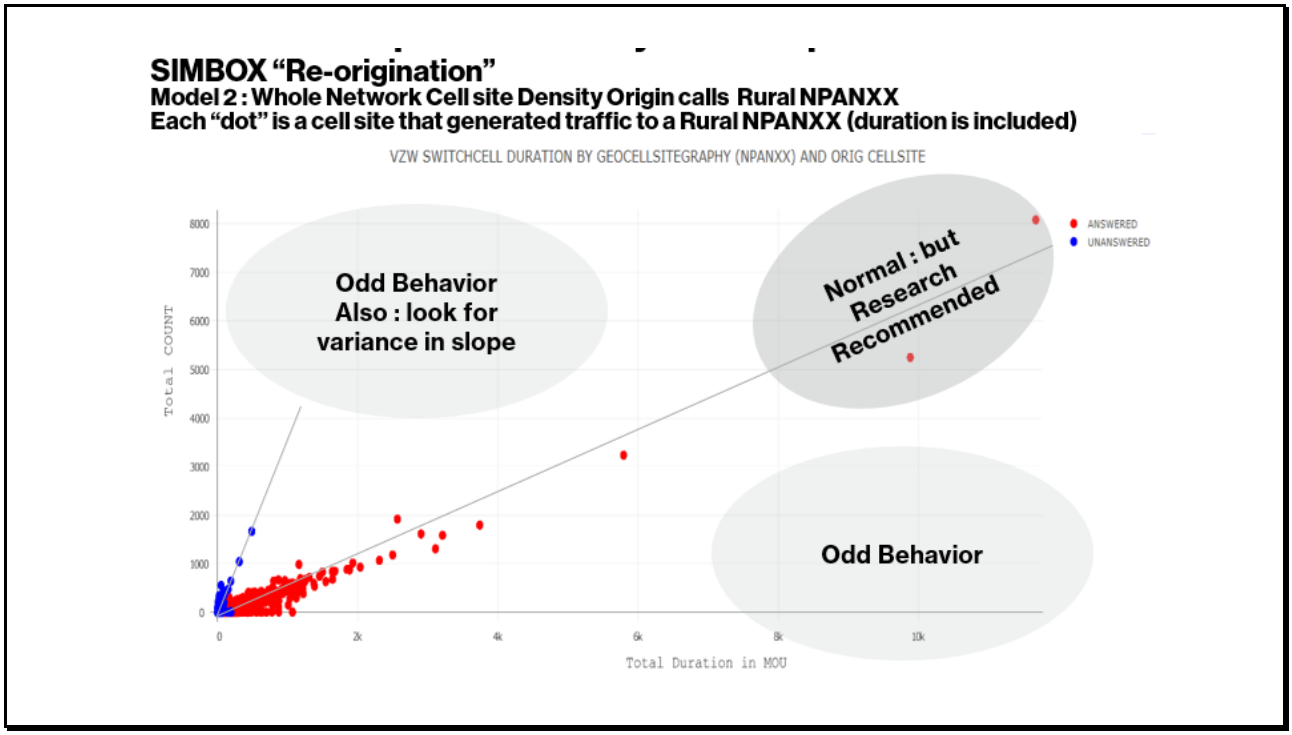
transport and termination). Rather, these investigations involved reviewing Verizon Wireless customer activity to look for potentially anomalous patterns of calls originating on the Verizon Wireless network.

Verizon looked for SIM-box fraud in two ways.

First, Verizon analyzed calls placed from individual mobile numbers, seeking to identify individual phones that were being used to originate large volumes of calls with significant minutes of use to rural OCNs.



Second, Verizon analyzed cell tower data to determine if mobile devices served by a single cell tower were being used to originate large volumes of calls with significant minutes of use to rural OCNs.



Verizon initially conducted these studies once a week beginning in October 2016. During the third quarter of 2017, as a result of an investigation into a call re-origination complaint involving Verizon Wireless services, described below, Verizon lowered the thresholds used to trigger investigations from these studies, and in October 2017 began conducting these studies twice a week. So far, these studies have not led to identification of additional fraud schemes.

3. Investigation of Complaints Regarding Call Re-Origination

While the above-referenced investigations did not identify any instance of call re-origination or SIM box fraud, Verizon did have the opportunity to investigate and take remedial action against three examples of call re-origination during the Consent Decree period as a result of complaints. In one instance, the provider was determined to be using a flat-rated wireline retail VoIP calling service in violation of applicable terms of service. In another instance, the provider was upstream of a Verizon wholesale customer. And in a third instance, it appeared that a single individual was using Verizon Wireless services purchased at retail by two of his companies to terminate wholesale traffic. All three instances involved manipulation of calling party number and were reported to Verizon as third-party complaints. Upon receipt of the complaints, Verizon terminated the customers or took other appropriate remedial action after careful investigation and detailed analysis.

4. *Investigation into Potential Calling Party Number Manipulation*

One of the potential concerns related to rural call completion is that calls are received with a calling party number ("CPN") that is different from the number that originated the call, as occurred in each of the above-discussed examples of re-origination. Verizon conducted a study to try to identify such activity. The study was coordinated with the assistance of another carrier that operated a tandem switch that served a large number of rural destinations. Verizon also placed calls to rural destinations that were served by Verizon's own tandem switches. Verizon placed many thousands of test calls using various third-party services, and then compared the calling number to call data from the tandem switch. If calling party number was manipulated, it likely would have occurred somewhere between the originating provider and the terminating tandem switch.

In the study, Verizon found only a single instance of CPN being changed. That call had been delivered with a changed CPN to a Verizon incumbent local exchange carrier ("ILEC") tandem that served the destination RLEC switch. Verizon met with an executive of the company that had delivered the call to Verizon. That company reportedly traced the issue to an upstream customer. The company ultimately declined to identify the customer at the end of the chain, but claimed to have taken steps with its customer to resolve the matter.

CPN Manipulation Study

- **Originated test calls to RLEC exchanges**
- **Compared records from origination and terminating tandem**

Origination	IXC Routing / Tandem	Number of Test Calls	Number of Instances where CPN Changed
Verizon Business local network switches	Various IXCs, Third-party tandem	2,588	None
Cricket, Magic Jack, T-Mobile, Boost Mobile, Google Voice, Consumer Cellular, Skype , Straight Talk, and Verizon Wireless.	Various IXCs, Verizon tandem	15,445	One*

*** CPN being changed by end-user of wholesale customer**

* * *

II. Other Information Regarding Avoidance, Investigation and Resolution of Rural Call Completion Issues

In addition to the investigations detailed above, Verizon has taken two other steps to look into and/or address potential rural call completion issues: (A) funding academic research and (B) limiting the number of intermediate providers in the call flow.

A. Verizon Funded Academic Research into Rural Call Completion Issues

As part of its efforts, Verizon commissioned academic research into methods to detect and resolve rural call completion issues.[9] Verizon awarded a $50,000 research grant to the Security and Software Engineering Research Center, for research to be conducted by Dr. Eric Burger, Research Professor of Computer Science at Georgetown University. The research effort spanned approximately eighteen months and included analysis of data from multiple providers. A copy of the resulting research paper is included at Exhibit C.[10] A summary of the research is as follows:

> *Changes to the wireline telephone network, including the introduction of new technologies such as SIP and the gradual reduction of wireline subscribers, has led to a network environment with higher reports of issues connecting calls to rural areas than there were ten years ago. Old network performance metrics seem incapable of identifying these previously unseen or unreported problems. The Federal Communications Commission (FCC) cites three factors: uncaptured or incorrect signaling, the presence of automated call traffic, and the increase of phone numbers without subscribers, which work together to reduce the capability of older metrics to measure network health. Using data from wireline providers and our knowledge of the symptoms of the connection problems, we created a new metric, called HMR* [Human Retries Metric]*, intended to be as independent from these factors as possible, with the intent being to deploy it to identify and resolve problems with calls to rural areas on a day-to-day basis or more frequently. While we were unable to completely disentangle HMR from some issues that cause problems for the old metrics, we were able to detect anomalies that potentially indicate problems that the other metrics were not able to capture. More work needs to be done to further reduce the influence of the complicating factors and to determine whether the data anomalies represent actual problems in the network.*[11]

[9] Consent Decree, § 18(b)[2].

[10] Exhibit C (Stohrer, T., Stewart, A., and Burger, E., *Issues, Analysis, and Tools For Rural Call Completion Issues,* 27 March 2017 (https://georgetown.box.com/s/cuf8vxvrlek5d4leto1spy0bz521ibxn) ("Research Paper")). *See also*, https://www.fcc.gov/ecfs/filing/104180548507226.

[11] Exhibit C (Research Paper) at 1.

B. Limiting Use of Intermediate Providers

Before the Consent Decree, Verizon used four intermediate providers for both rural and non-rural traffic. Verizon also used services from alternative tandem providers for calls to non-rural areas and to rural competitive local exchange carriers ("CLECs").

As part of the Consent Decree, Verizon agreed to limit its routing of calls to rural ILECs to intermediate providers who agreed to have no more than one additional intermediate provider in the call flow.

The Consent Decree afforded Verizon six months within which to implement changes to its use of intermediate providers, and it took almost that entire time to implement contract amendments with Verizon's selected vendors. Ultimately, Verizon was able to implement appropriate contracts with two of its four intermediate providers, and during the Consent Decree (and thereafter), Verizon's use of intermediate providers for calls to rural ILECs has been limited to just those two. One of those intermediate providers stated that it would not use any additional intermediate providers. The second intermediate provider agreed that the additional intermediate provider must be selected from among a limited list of additional intermediate providers approved by Verizon in advance.

* * *

III. Lessons Learned

Rural call completion issues can manifest in a variety of ways. For purposes of this Report, this section on lessons learned is organized as follows: (A) impairment of call completion, (B) manipulation of calling party number, (C) degradation in call quality, and (D) selected remaining issues.[12]

A. Impairment of Call Completion

This topic encompasses a wide range of reasons why calls might not complete properly. It includes situations such as where the call was never offered to the far-end customer, the call was delivered only after the caller heard an extended period of ringing, the called party's phone rang but the called party heard nothing upon answering, false busy signals, calls that didn't complete due to network congestion, and other such situations where the PSTN does not function in a way the user expects or otherwise does not complete the call. One of the primary areas of activity under the Consent Decree was to try to determine if metrics-based investigation techniques are capable of detecting persistent or recurring rural call completion issues. In that regard, Verizon learned the following lessons from its metrics-based investigations:

Metrics Must Be Carefully Tailored. Metrics-based investigation programs should be calibrated to identify persistent or recurring issues that impair rural call completion. The goal should be to identify and remediate "persistent unreachability," not normal or minor variations in rural call completion rates.[13] Providers may quickly exhaust resources if methods and procedures for metrics-based investigation are not carefully designed. Providers require latitude to explore various metrics and alter their approach until they find a method that minimizes false positives and is efficiently identifying systemic issues.

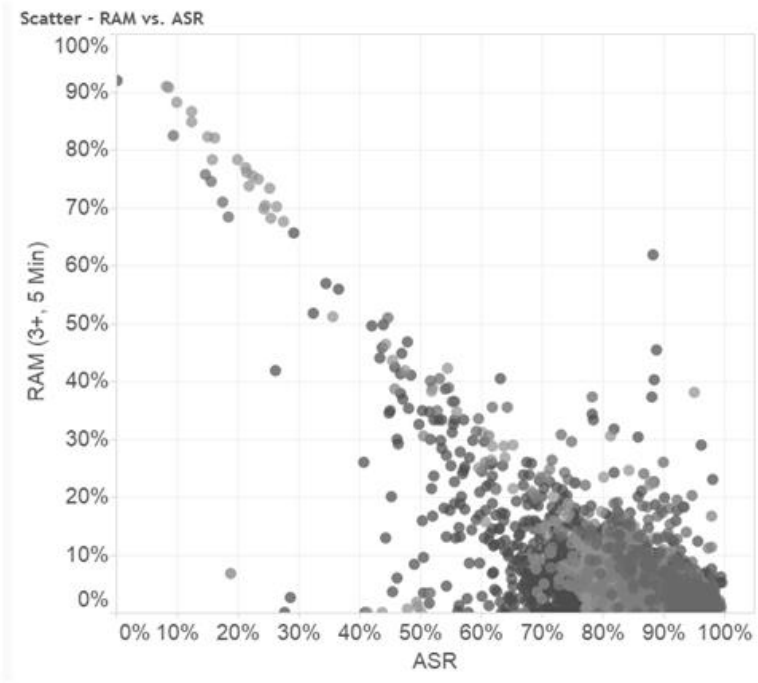
A Wide Range of Metrics May Be Suitable. There are likely a wide range of metrics that are suitable for various types of issues and various provider IT and system environments. Some metrics, like Answer Rate, RAM, and HMR, seek to identify a wide range of situations that might interfere with a desired outcome (e.g., an answered call).[14] Other metrics, like post-dial delay, post-answer delay, and call cut-

[12] *See*, Exhibit B, Rural Call Completion Industry Workshop presentation (April 22, 2015) ("Workshop I"), at slide 7 (characterizing "three types" of rural call completion issues as originating caller number changed, ring no answer, and poor call quality); ATIS Handbook at §1.3.1 (call completion failure, poor transmission quality, and misidentification of calling party as examples of problems reported).

[13] Exhibit B (Workshop I) at slide 32 ("Call completion is not engineered to be perfect and transient variations and occasional problems are expected, BUT situations where customers are not reliably reachable by some parties are NOT acceptable.") and slide 44 (focus on "systemic" problems); ATIS Handbook at §4.1.

[14] Exhibit C (Research Paper) at 8 (the Human Retries (HMR) metric was born from an attempt to anticipate how callers would respond to any number of a wide range of call completion issues…by trying again). *See also*, discussion of RAM in this paper. Such issues could be anything from hearing dead air upon answer, to hearing too many rings, to not hearing rings soon enough, to hearing an unexpected recording or announcement, to experiencing poor call quality upon answer.

off rate seek to identify a specific type of call completion impairment.[15] With respect to the various metrics that attempt to identify call failures generally, there is some indication that the various metrics may perform in similar ways within a common data set or analytical method, indicating that success in certain metrics-based investigations into call completion may turn less on the precise metric picked and more on the ways in which it is analyzed.[16] For example, although there were meaningful differences in the way in which Verizon calculated Call Answer Rate and RAM, those metrics display a visual similarity, as noted in the chart below.[17]



Based on data for 4.9M call attempts over a 10-day period in October 2016 to a small sample of both rural and non-rural local exchange carriers. Each dot represents a group of 100 or more call attempts to a single CLLI on a single day. Each dot is plotted based on its RAM and Call Answer Rate.

Focusing and Narrowing the Analysis Yields More Efficient Results. Verizon found it was more efficient to analyze metrics over a narrower period of time (one-day periods for the Negative Spike metric), within a single destination (OCN), than to calculate metrics over a month and compare them to

[15] ATIS Handbook at §6.7 (table 6.1)

[16] Exhibit C (Research Paper) at 5 (describing correlation between Answer Rate (ASR) and Network Effectiveness Ratio (NER)); Exhibit B (Workshop I) at slide 28 (comparing scenarios where NER and ASR might be used); ATIS Handbook at §4.2 ("variety" of measurements).

[17] Verizon did not test Call Answer Rate and RAM for statistical correlation.

a population-level baseline. Verizon's use of the Negative Spike metric, which compared daily performance for each rural OCN to the seven-week historical trended average for that same destination identified network issues as the root cause in 7 of 26 instances (27%) (none of these seven issues was on the Verizon network). By comparison, Verizon's use of Call Answer Rate, which looked for situations where the monthly Call Answer Rate for a particular OCN fell below 80% of the aggregate rural answer rate in the prior month identified network issues as the root cause in 13 of 176 investigations (7%) (one of which was on the Verizon network). And Verizon's use of RAM, which investigated instances where RAM spiked above 20%, identified network issues with other carriers as the root cause in 5 of 34 investigations (15%).

Monitoring for performance within a single destination may help to better control for variations across destinations in signaling practices, customer demographics (mix of business and residential lines), and end-user behavior.[18] Monitoring against prior performance that includes a uniform mix of days-of-the-week may help to control for variations in end user calling patterns and other such factors.[19] Although Verizon calculates performance metrics for many aspects of its network using time intervals as short as five minutes, the relatively low volume of calls to many rural destinations led Verizon to design the Negative Spike metric to calculate Call Answer Rate for a 24-hour period. In addition, in its RAM studies, Verizon flagged CLLI's for further investigation only if the calculation of the daily RAM value was based on 100 or more call attempts.

Similarly, Verizon determined that it was more efficient to analyze metrics at the level of an individual CLLI code rather than an entire OCN. CLLI is an acronym for Common Language Location Identifier—a number identifier for a specific PSTN location or device. When Verizon measured Call Answer Rate, it calculated the metric for each rural OCN. In the context of Verizon's Call Answer Rate investigations, 47% of the rural OCNs had 2 or more CLLIs; 17% of the rural OCNs had 5 or more CLLIs. A low Call Answer Rate for a single CLLI might drag down the overall Call Answer Rate for the entire OCN. Conversely, a high Call Answer Rate for an OCN can mask a low Call Answer Rate for an individual CLLI.

Differences in Signaling Practices and Use of Cause Codes Can Impact Metrics. Variation in signaling practices can have a great impact on the performance of call quality metrics. Industry standards define a variety of numeric codes that may be communicated between providers in signaling messages to help explain the reasons for particular events on the PSTN. For example, in signaling system 7 (SS7), a common signaling protocol on the PSTN, a cause code of 16 means the call ended normally; 17 means the called party's line was busy; 1 means that the number called is not in service; and 34 means no circuit was available at the destination. There are three primary standards that define cause codes for industry use and over a hundred different cause codes.[20] And metrics such as ASR

[18] *See,* Exhibit B (Workshop I) at slides 25-27 (monitoring intermediate provider behavior to same destination during same time of day (peak busy hour)).

[19] *See,* Exhibit B (Workshop I) at slides 25-27 (all carriers performed acceptably other than during peak busy hours); Research Paper at 12 (business cycles and human circadian rhythm impose weekly and daily patterns…to call volume and frequency).

[20] ATIS Handbook at §5.1.2.1.2.

(answer rate) and NER (network effectiveness ratio) often rely on cause codes exchanged in signaling messages between interconnected providers.

However, there is no binding or mandatory implementation of cause codes. Thus, there is the potential for significant variation in how different equipment vendors, system integrators, and providers implement and signal cause codes which, in turn, impacts the metrics that rely on those codes. For example:

- In April 2015, Verizon investigated an end office with a Call Answer Rate of 10%. Verizon attributed the low Call Answer Rate to 45,385 calls to a single, unassigned number for which the Rural LEC was providing a cause code of 22 (number changed) instead of a cause code of 1 (unallocated number). Use of 22 instead of 1 was causing a low Call Answer Rate due to the calculation of the Call Answer Rate formula (which counts a number as not in service only if a cause code of 1 is returned). Verizon contacted the RLEC to discuss the situation. The RLEC advised that the called number was in fact an unassigned number that was being used by an auto-dialer customer as the called-from number. People who were called by the auto-dialer were calling the number back (most likely to ask not to be called). Later the same day, the RLEC advised Verizon that it had changed a parameter in its switch to return a cause code of 1 rather than 22.

- In May 2015, Verizon investigated an OCN with a Call Answer Rate of 37%. Verizon attributed the low Call Answer Rate to 1,254 calls to unassigned telephone numbers. The RLEC was sending a cause code of 3 (no route to destination) instead of a cause code of 1. After contacting the RLEC, Verizon learned that the RLEC was migrating to a new soft switch. The RLEC agreed to make sure the switch was configured to send a cause code of 1 for calls to unassigned numbers.

- In July 2015, Verizon investigated an OCN with a Call Answer Rate of 47%. When Verizon reviewed the CDRs, it found that calls receiving a RWC 31 (normal unspecified) represented a relatively high percentage – 35 percent – of the total call count. Test calls to these numbers all produced a fast busy signal. Based on the test calls and SS7 trace data, Verizon determined that RLEC was sending a cause code of 31 on calls to unassigned numbers rather than a cause code of 1.

- In December 2015, Verizon investigated an OCN with a Call Answer Rate of 35% on 520,455 calls. Verizon ultimately was informed by the RLEC that fifteen of the OCN's end offices are equipped with older switches that are not capable of providing an SS7 cause value of 1.

Such variability undermines the utility of cause-code-based metrics for making comparisons across different destinations.

Complicating the situation is that there are different protocols in use on the PSTN—SS7, Session Initiation Protocol (SIP, for VoIP traffic), and older multi-frequency (MF, analog) signaling protocols. Each has its mechanism for communicating cause information, and interworking between these

different protocols can sometimes cause the reasons for events, as reflected in the cause codes, to get lost in translation.

The intersection between call signaling implementations and end user behavior can also have a significant effect on use of metrics. When a call is ended (by one user hanging up), the provider for the user that hangs up first sends a "release" message to the other party's provider. Typically, when a user hangs up, the cause code in that release message is a 16 (normal call clearing). As a practical matter, however, this is a race condition (the cause code received by all carriers may be different depending on whether it is the calling or called party that hangs up first). So, for example, if a caller dials an unallocated number, the terminating provider may play an announcement ("We're sorry; your call cannot be completed as dialed. Please check the number and try again").[21] If the caller hangs up before the announcement completes, the caller's provider sends the release message with a cause code of 16 (normal call clearing). Unless the calculation of the metrics is capturing the *direction* of the release message (*i.e.*, coming from the caller's side instead of the terminating side), the bare cause code of 16 in the release message (which came from the originating provider) disguises the fact that the call was to an unallocated number. The direction of the release is a data element that might aid in analysis of metrics.

One of the ways to get greater visibility into the meaning of call signaling activity is to capture one of the intermediate signaling messages. In SS7, the Address Complete Message (ACM) is sent by the terminating provider when the terminating provider is ready for the audio path to be opened so that the caller can either hear ringing or some sort of announcement. The ACM message can contain an optional cause code. Verizon determined that, in some instances, access to the ACM and its cause code gave additional insight into the nature of the called number. Specifically, many providers will include a cause code of 1 in the ACM (indicating the number is not in service), but then play a recorded announcement, during which the caller will hang up, generating a release message from the originating provider with a cause code of 16. If a provider is only capturing the cause code in the release message, the nature of the called number is ambiguous. But if the ACM is captured with its corresponding cause code, the fact that the called number is not in service is readily apparent.

The variability in signaling practices across different terminating providers greatly complicates the process of using metrics to make performance comparisons between different destinations. Overall, 135 of 176 (77%) of Verizon's investigations into low monthly Call Answer Rates were triggered by variations in signaling practice.

Retained Records Support Metrics-Based Monitoring. FCC regulations require retention of records that could be useful for a monitoring program.[22] The data elements required to be retained by the FCC

[21] ATIS Handbook at §5.1.2.1.5.4.

[22] 47 CFR § 64.2103(f). The FCC requires covered providers to retain (1) The calling party number; (2) The called party number; (3) The date; (4) The time; (5) An indication whether the call attempt was handed off to an intermediate provider or not and, if so, which intermediate provider; (6) The rural OCN associated with the called party number; (7) An indication whether the call attempt was interstate or intrastate; (8) An indication whether the call attempt was answered, which may take the form of an SS7 signaling cause code or SIP signaling message code associated with each call attempt; and (9) An indication whether the call attempt was completed to the

permit a provider to calculate an answer rate for each terminating OCN for each of the intermediate providers it uses. The data also permit that answer rate to be calculated on a trended basis, as described above, which would allow providers to gain an understanding of the relative performance of their different intermediate providers (and themselves) to each rural OCN. In addition to answer rate, the FCC-required data set would permit calculation of RAM and HMR. The data set would also permit removal of call attempts by auto-dialers and call attempts to unallocated numbers, which, as noted below, were found by Verizon to be useful modifications to call attempt data.

Call Attempts from Auto-Dialers Should Be Eliminated When Calculating Metrics. Verizon's experience indicates that call attempts from auto-dialers should be eliminated when calculating metrics used for monitoring. Auto-dialers are computers or other machines that can automatically place calls. There are a number of reasons why it may be useful to omit such call attempts from the calculation of metrics.

Auto-dialers can generate a significant volume of traffic. In one thirty-day study of 39.43 million call attempts on Verizon's network, 20.23 million of them (51%) were estimated to have been placed by auto-dialers.[23] Verizon identified as auto-dialers those originating numbers that attempted more than 60 calls during any one-minute period during the prior 90 days. Similarly, the academic research team at Georgetown had a data set that contained 20.3 million unique originating numbers compiled from Verizon, Level 3, and inContact.[24] The team categorized an originating number as being associated with an auto-dialer if that number had placed over 1,400 calls/day during the course of a month.[25] Of the 20.3 million unique originating numbers in the data set, only 3,449 (0.17%) met the auto-dialer criteria, but those 3,449 numbers accounted for 42% of the call attempts in the data set.[26]

Auto-dialers behave differently from human callers. Many auto-dialer systems place calls to blocks of numbers indiscriminately, irrespective of whether the numbers are in-service.[27] Auto-dialer systems can also be configured to generate significant volumes of repeated call attempts. Because the marginal cost

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incumbent local exchange carrier but signaled as busy, ring no answer, or unassigned number. This indication may take the form of an SS7 signaling cause code or SIP signaling message code associated with each call attempt.

[23] Exhibit D (Workshop II) at slide 16.

[24] Exhibit C (Research Paper) at 4, 6.

[25] Exhibit C (Research Paper) at 6, n.23.

[26] Carriers have tried to identify auto-dialer traffic in other ways as well. The FCC reported that eight different providers attempted to segregate auto-dialer originated traffic on the Form 480s submitted to the FCC. *In the Matter of Rural Call Completion, Report, DA 17-595, Released June 22, 2017* ("FCC Data Report") at pp. 31. Verizon was not one of them. Those providers used various criteria, "including proxies based on originating numbers that had a specific number of call attempts in a defined period (e.g., at least 1,000 call attempts in a day; more than 720 call attempts in any day of the reported month; more than 360 call attempts per hour in a 24-hour period and a call answer rate of less than 25 percent; at least 5,000 call attempts in a month with an average call duration of less than or equal to 18 seconds)."

[27] Exhibit C (Research Paper) at 5.

of placing calls is low, auto-dialers may quickly retry unsuccessful call attempts. In one particularly extreme example from the academic research main data set, there were 428 records of one number calling another over about six and a half minutes.[28] This type of activity has the potential to degrade metrics-based performance. In this example, all but two of the 428 calls received a cause code of 3, and would have been counted as failed call attempts under an ASR or NER metric, making it appear as if there were a network problem.[29] And while there appears to be a certain regularity to certain types of auto-dialer activity in general (they always call during dinner), much of the auto-dialer traffic is not patterned, but rather is episodic. These episodes can generate significant volumes of traffic to highly localized areas in an unpredictable manner. Verizon investigated many instances of auto-dialer traffic generated by political campaign activity, corporate marketing, and public services (such as school closing and weather alerts).

- In May 2015, Verizon investigated an OCN with a Call Answer Rate of 27% on 17,240 calls in that month, 7,504 of which (44%) originated from a single number. The calling number was linked to a survey company through online research. All of these auto-dialer calls occurred on May 1st and 2nd. Ninety-four percent of them went unanswered with a RWC 16 and no call duration. This appears to have been a one-time event that reduced the Call Answer Rate from 58% in April to 27% in May.

- In May 2015, Verizon investigated an OCN with a Call Answer Rate of 33% on approximately 75,000 calls. Verizon attributed the low Call Answer Rate to 68,567 calls from one number that were made in a short time period on a single day. The number belongs to a public service announcement system, which is an auto-dialer used by government agencies to launch recorded messages for issues such as school closings and weather-related emergencies.

- In June 2015, Verizon investigated an OCN with a Call Answer Rate of 11% on 4,720 calls for a two-day Negative Spike (the 35-day trended Call Answer Rate for that OCN was 61%). Verizon attributed the low Call Answer Rate to calls from one auto-dialer number that represented 71% of the total call attempts to the OCN during the investigation period. All calls from this number were receiving a Release code of 21 (call rejected) from the Rural LEC switch. Verizon contacted the terminating LEC on June 24, 2015, and was informed that the LEC had intentionally put an automatic block on the calling number after receiving customer complaints.

- In September 2015, Verizon investigated an OCN with a Call Answer Rate of 36% on 25,611 calls. The OCN had three end offices, one of which had a Call Answer Rate of 12% (which was responsible for the overall low performance for the OCN as a whole). Verizon attributed the low Call Answer Rate to congestion in the destination network that resulted from a high volume of auto-dialer calls. During a one-hour period on a single day, 11,435 calls (45% of the total call

[28] Exhibit C (Research Paper) at 7. Indeed, the HMR metric ignores repeated call attempts made within a 13-second period, in part, to mitigate the impact of auto-dialer retries. Id. at 8 ("In our observations of the data it takes low volume callers at least 13 seconds to retry a call.").

[29] Exhibit C (Research Paper) at 7.

attempts) failed with a RWC 34 (no circuit available). Of those calls, almost all (11,214) came from the same originating number.

Finally, auto-dialers typically appear to end users to be calling from unfamiliar numbers, may engage in spoofing of the originating number, and may get flagged by mobile apps or third-party services as "spam," all of which can deter normal answering behavior by the called party, and which may have some impact on metrics-based calculations.

Elimination of auto-dialer traffic from the calculation of metrics may be beneficial for two reasons. First, the volume of auto-dialer traffic increases the cost and time associated with retrieving data, processing data, and storing data associated with calculation of metrics. Second, the unpredictability and localized impact of many auto-dialer campaigns tends to generate false-positive events in metrics-based monitoring. Auto-dialer impact was observed even with the use of the Negative Spike metric, which attempted to control to some degree for destination specific factors such as signaling practices, end user mix and calling patterns, terminating destination and tandem, by monitoring traffic to a single destination and comparing daily performance to the average for that same destination over the prior 35-day period. Six of the 26 Negative Spike investigations (23%) were triggered by auto-dialer activity.[30]

To say that providers may want to exclude auto-dialer attempts from the calculation of metrics does not mean that the data is not useful—only that it may be advisable to exclude such calls from the calculation of metrics.[31] If metrics-based monitoring indicates a potential problem with call termination to a particular destination, the availability of the auto-dialer originated call attempts for the time period in question can sometimes significantly shorten the investigation by allowing prompt identification of the root cause (*i.e.*, the auto-dialer traffic).

Calls to Unassigned (Not in Service) Numbers Impact Metrics. Call attempts to numbers that are unallocated (aka, not in service, or unassigned) figured prominently in Verizon's initial investigations into Call Answer Rate, including the Negative Spike investigations. The formula used to calculate Call Answer Rate for both the monthly and Negative Spike investigations sought to exclude call attempts to unassigned numbers (which cannot be answered) by excluding calls that received a cause code of 1 in the release message. Thus, accurately identifying calls to unassigned numbers became an important aspect of the metric's utility. As already detailed above, however, the lack of consistency among carriers in signaling practices with respect to cause codes, and the ability of providers to signal a cause code of 1 in the ACM message instead of the release message, means that simply looking for a cause code of 1 in the release message likely undercounts the volume of calls to unallocated numbers. It also meant that

[30] Exhibit D (Workshop II) at slide 9.

[31] Exhibit C (Research Paper) at 12 ("building good methods for filtering robo-callers is still going to be necessary to get the noise out of the data so carriers can focus on real network impairments"); at 14 ("We deeply believe that improving methods for filtering noise in the form of calls from robo-callers and to improperly signaled disconnected numbers out of the data will go a long way to improving HMR and other existing metrics."); FCC Data Report at 32 ("Nevertheless, because there remain differences between auto-dialer and non-auto-dialer traffic among those providers that make such a distinction in all of their reports, it appears that the inclusion of auto-dialer traffic has an effect on call answer rates.").

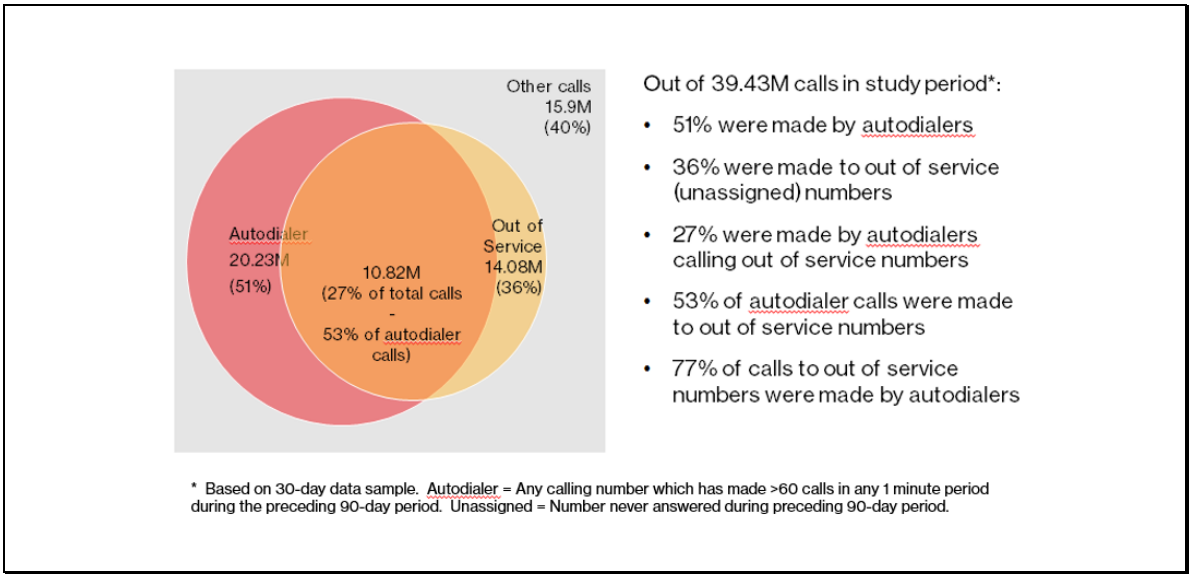
when Verizon received a cause code other than a 1 for calls to unassigned numbers, Verizon did not exclude those call attempts from calculation of Call Answer Rate. Because none of those call attempts was ever answered, the metrics indicated poorer performance.

Cause codes are not the only way to try to identify unassigned numbers. For its use of the RAM metric, Verizon treated a called number as unassigned if it had not answered any call during the prior 90-day period. And the Georgetown researchers considered any terminating number that had no answered calls in the data set to be unassigned.[32]

To ascertain the extent to which limiting the unassigned number exclusion only to calls signaled with a cause code of 1 in the release message potentially undercounts the volume of calls to unassigned numbers, Verizon compared the frequency of cause code 1 in the release message for call attempts reported to the FCC on Form 480 for the fourth quarter of 2016 to the frequency of unassigned numbers identified in the data sets used to calculate RAM (which were from roughly that same time period). Cause code 1 in the release message was present for 11% of the calls reported on the Form 480; Verizon's RAM study identified 36% of calls as being to numbers that had never been answered during the prior 90-day period.

Variations in signaling practices across terminating carriers with respect to unassigned numbers and the varying amounts of unassigned numbers present in each terminating carriers' number allocation might not pose an obstacle to the use of metrics if those numbers were not getting called. But they are getting called, frequently, by auto-dialers, because that is the nature of their business.

Verizon analyzed a 30-day set of call records to the destinations used for the RAM study and determined that auto-dialers frequently call unassigned numbers.



[32] Exhibit C (Research Paper) at 7, n.33.

Ultimately, accurately accounting for calls to unassigned numbers is important in developing a metric for monitoring or triggering an investigation.[33] In addition, accurately identifying unassigned numbers in the data set can serve as an indirect method of identifying additional auto-dialer traffic for exclusion.[34] To that end, Verizon also analyzed the frequency of cause code 1 in the release message for call attempts reported by Verizon Wireless to the FCC on its Form 480 for the fourth quarter of 2016, and found that only 1% of call attempts had a release code of 1; this is expected because that data set comprised almost completely call attempts from mobile phones.[35]

End User Behavior Affects Metrics. End user behavior affects Call Answer Rate and RAM. With respect to Call Answer Rate, Verizon compared its Form 480 data filed for its wireline long distance networks to Form 480 data submitted by Verizon Wireless for the subset of calls that Verizon Wireless did not route to Verizon Business. The Verizon Wireless traffic contained little to no wholesale or auto-dialer traffic, and the call answer rates reported on the Verizon Wireless Form 480 were consistently, meaningfully, higher than the call answer rates reported for Verizon's wireline long distance networks, which carry a broad mix of retail, enterprise, and wholesale traffic. With respect to Verizon's investigations, 20 of 172 Call Answer Rate investigations (11%); 16 of 26 Negative Spike investigations (62%); and 20 of 34 RAM investigations (59%) were triggered by end user behavior, such as auto-dialers, mass-calling events, single-number events or other end-user repeat calling situations (fax machines, retries on busies, etc.).

Metrics-Based Monitoring Will Identify Network Issues. In a few instances, Verizon's metrics-based investigations identified technical issues with the network or call routing that either Verizon or the terminating RLEC were able to address. For example:

- In May 2015, Verizon investigated an OCN with a Call Answer Rate of 32% on 5,949 calls for the month. The investigation revealed that the RLEC had recently replaced its switch with a new switch and that the cause codes had not yet been properly configured in the new switch. The RLEC stated that it already had a ticket open with its vendor to correct the issue.

- A May 2015 investigation of an OCN with a 16% on 8,872 calls for the month revealed a call looping condition between the RLEC's end office switch and Verizon's network. Verizon worked with the RLEC to correct the situation.

[33] Exhibit C (Research Paper) at 5 ("when we calculate both ASR and NER we exclude calls receiving code 1 from our calculations as these calls introduce a tremendous amount of statistical noise and make network performance appear much worse than it is.") ("a large percent of calls receiving code 1 tells us much more about the profile of those placing calls to a particular area and the allocation of the numbers in that area, than it does about a network's ability to deliver calls there.").

[34] Exhibit C (Research Paper) at 5 ("On the other hand, when humans place calls they tend to call people and businesses. Except in the relatively rare cases of a mis-dialed, changed, or a recently disconnected line, calls to people from people do not typically receive code 1.").

[35] Exhibit D (Workshop II) at slide 16.

- A June 2015 investigation identified the need for Verizon to make changes to network translations to correct routing for a rural NPA-NXX that had been decommissioned from the LERG.

- A June 2015 investigation identified an error in the routing logic in the RLEC switch that the RLEC was able to fix.

- A December 2015 investigation identified a situation where calls to unassigned numbers were looping between tandem and end-office switches, which was resolved by the RLEC making a correction to the translations in it switch.

- A significant one-day network outage at one of Verizon's intermediate providers caused RAM to spike significantly for all destinations for which Verizon was using that intermediate provider. That outage also affected call completion for other IXCs.

The recommendations in this Report may help to make monitoring programs more efficient.

B. Calling Party Number Manipulation

Calling party number manipulation can lead callers to not answer calls, may result in improper rating of calls for compensation purposes, and may impair call completion in other ways.[36]

Calling party number manipulation cannot be detected by any provider without access to data at multiple points in the call flow. The examples of calling party number manipulation discussed above were all detected through testing and included access to signaling data at two different points in the call flow. In the situations described involving Verizon's retail and wholesale customer, the test calls were placed by a third party (calling its land line from its mobile phone). Verizon's proactive investigation into calling party number manipulation over various third-party calling services involved access to data at two different points in the call flow—call origination and the terminating tandem.

Call re-origination and use of a SIM-box are not required in order to change calling party number. Calling party number could, as a technical matter, be changed unilaterally by any provider in the call flow, although FCC regulations prohibit intermediate providers from changing or manipulating calling party number and certain other signaling parameters.[37] However, call re-origination over retail services and SIM-box fraud create an additional financial opportunity for the perpetrator: the opportunity for the perpetrator to receive calls as an intermediate provider, for which it would typically be paid usage-based charges for such wholesale services, and to terminate those calls over flat-rated voice services for which

[36] Exhibit B (Workshop I) at slides 18-23 (Incentives for Financial Arbitrage); ATIS Handbook at §5.1.1.2 (changes in CPN delivered may interfere with terminating the call); §5.1.1.1 (missing CPN may interfere with termination if anonymous call rejection is engaged by the called party).

[37] 47 CFR 64.1601(a), (d), (delivery requirements and privacy restrictions and exceptions).

it typically pays low monthly fixed fees as a retail customer, irrespective of call jurisdiction, volume, or destination.

Flat-rated retail calling services are widely available from providers such as cable companies, VoIP companies, wireless companies, and traditional telecommunications companies.[38] Although some providers likely already monitor those retail services for fraud and abuse, it's not clear the extent to which existing monitoring would detect use of those services for arbitrage targeted at geographic areas.

C. Degradation in Call Quality

Call quality complaints typically relate to the user's experience once a call is established, such as static, noise on the line, choppy voice, or echo.[39] There are measures of call quality that intermediate providers may employ.[40] During the Consent Decree, Verizon received few, if any, complaints from the Bureau or to Verizon's rural call completion hotline related solely to call quality, and Verizon's activities under the Consent Decree did not focus on direct measures of call quality. Poor call quality, however, is a factor that may lead to repeat call attempts and thus would be indirectly captured to some degree in the RAM and HMR metrics.

D. Selected Remaining Issues

In addition to the foregoing, Verizon's efforts led to "lessons learned" with regard to investigating complaints, limiting the use of intermediate providers, and managing congestion from certain auto-dialer traffic.

1. Investigating Complaints

Investigating individual complaints is a useful way of identifying and resolving call completion issues. Unlike metrics-based indicators, complaints are almost always grounded in an abnormal or atypical calling experiences, and the complainants are often willing to provide information about their experience and to participate in follow-up testing. The ATIS Handbook and Workshop I materials contain a range of suggestions for investigating complaints.[41] For purposes of this report, Verizon

[38] Exhibit B (Workshop I) at slide 24 (noting that there are multiple "technical possibilities for entry into rural networks: Sim boxes, VOIP gambits via Cable modems, OTT systems" which result in "access calls being injected as local traffic into RLEC local network.").

[39] ATIS Handbook at §5.2.

[40] ATIS Handbook at §6.7. It was suggested at Workshop 1 that too many instances of signal conversion (from digital to analog and back) in the call path may lower call quality. Exhibit B (Workshop I) at slides 8-9.

[41] ATIS Handbook at §7 (prompt reporting of troubles is "imperative;" collaboration is "important;" and promptly involving all parties in the call path to investigate is "key"); §7.1.2.1-7.1.2.2 (enumerating requirements for carriers reporting troubles and for carriers receiving trouble reports). Exhibit B (Workshop I) at slides 12-16.

wishes to highlight its experience with complaint investigation in two respects—the establishment of a dedicated team and the use of test lines.

- Some providers will only respond to complaints initiated by their customers.[42] This can be a significant barrier to investigation of rural call completion issues because complaints are often raised by someone other than the intermediate provider's customer. Verizon has developed a small dedicated group of personnel who received access to appropriate tools and systems, were trained on issues related to rural call completion, and developed expertise and efficiency in investigating and resolving complaints regarding rural call completion. Having a dedicated team of personnel who are trained in advance and have developed experience in investigating and remediating rural call completion complaints has made that process much more efficient for Verizon.[43]

- Test lines can be useful, but only with meaningful cooperation by all parties. The Consent Decree required Verizon to engage in testing using test lines with any requesting rural carrier. Verizon established a website and publicized its willingness to engage in such testing.[44] Only one carrier requested such testing during the three-year Consent Decree period. Similarly, during its investigations into Call Answer Rate, Verizon initially requested that RLECs engage in milliwatt testing as part of Verizon's investigations. Of the 124 RLECs with which Verizon sought to perform milliwatt testing, only 53 provided valid test numbers. That said, test lines may be useful in some contexts, such as automating testing with a specific destination for a period of time as part of trouble-shooting intermittent connectivity or quality problems, and to isolate testing to the core network (switch to switch) to the exclusion of the last-mile local loops and end-user CPE.[45]

2. Limiting Use of Intermediate Providers

Use of intermediate providers is not a bad thing.[46] It is, in fact, very necessary. As stated in the ATIS Handbook, "[n]ot all originating [service providers] have direct connectivity to the terminating end

[42] ATIS Handbook at §7.1 (carriers may not accept trouble reports "because industry guidelines expect each carrier to only work troubles reported by their customer").

[43] Exhibit B (Workshop I) at slides 54-55 (discussing Comcast's use of a "national voice team" in investigating call completion issues); ATIS Handbook at §7.1.2.1-7.1.2.2 (carriers should have "trained personnel" for reporting and investigating rural call completion complaints).

[44] Verizon established a website and distributed a brochure during its first workshop to all participants and attendees. *See*, http://www.verizon.com/about/rural-call-testing.

[45] ATIS Handbook at §7.2.1 Use of Test Lines for Call Completion Trouble Resolution.

[46] Exhibit B (Workshop I) at slide 24 ("Least-Cost Routers ("LCRs") are efficient tools that providers everywhere use to route calls based on each call's cost. HyperCube's study reveals that LCRs themselves do not necessarily contribute to call-completion and call-quality problems."); Id. at slide 33 ("Point is not that LCR is bad; just that it must be done right! Carriers may have to rely on others for universal reach").

offices to which given NPA/NXX codes are assigned or to the access tandems to which the terminating switch is homed on in the LERG Routing Guide. Additionally, originating [service providers] may opt to route through other providers due to various network conditions (for example, network congestion) to reach the terminating end office."[47] Innovation, and new voice services would not be possible unless those service providers could leverage the existing PSTN long distance facilities owned by third parties for call transport and termination. Verizon considered a number of questions in restricting its use of intermediate providers under the consent decree.

- What is an intermediate provider?

FCC regulations define an intermediate provider as "any entity that carries or processes traffic that traverses or will traverse the PSTN at any point insofar as that entity neither originates nor terminates that traffic."[48] But that does not tell the full story. Operators of tandem switches—switches that form part of the PSTN network architecture and to which long distance providers may be expressly directed to terminate traffic for specific end-office switches by the Local Exchange Routing Guide (LERG)--are entities that neither originate nor terminate traffic. But in some instances, rural ILEC end offices can only be reached through the designated tandem provider.[49] Accordingly, in its First Report and Order, the FCC clarified:

> *91. Some commenters seek clarification on whether, if a provider other than the terminating rural ILEC operates the terminating tandem switch, that provider counts as an intermediate provider for purposes of eligibility for this safe harbor. We clarify that it does not. Our experience in investigating rural call completion complaints indicates that when a call does reach the terminating tandem, regardless of ownership, it is completed by the rural ILEC with a very high degree of reliability. Accordingly, if a provider merely operates a terminating tandem that delivers traffic to a rural ILEC, delivering traffic to the terminating tandem operated by that provider does not count as using an additional intermediate provider for purposes of this safe harbor.*
>
> *If, however, an intermediate provider delivers traffic to the tandem operator somewhere other than the terminating tandem—so, for example, the tandem operator also provides transport on the network side of the tandem—then that provider does count as an intermediate provider for purposes of this safe harbor.*

This distinction, coupled with the emergence of competitive providers offering alternatives to ILEC-provided tandem services ("alternate tandem providers"), has the potential to create some complexity in the implementation of the FCC's rules on rural call completion insofar as the use

[47] ATIS Handbook at §5.3.4.1.

[48] 47 CFR 64.1600(f).

[49] *Report and Order and Further Notice of Proposed Rulemaking, In the Matter of Rural Call Completion, FCC 13-135, released November 8, 2013,* at pp. 91 fn. 241 ("First Report and Order") ("Many rural ILECs can only be reached through tandems owned by other carriers, such as a larger regional ILEC or a state access network.").

of alternative tandem providers is concerned. Network efficiency might dictate creation of just a few interconnection points with a provider of alternative tandem services, but the geographic proximity of that interconnection point to the tandem switches might mean that for some of the traffic the alternative tandem provider is acting as an intermediate provider and for other traffic it is not. While this may not pose a major obstacle to monitoring (the performance of the alternative tandem provider could simply be monitored with respect to all of the traffic delivered to it), it does present challenges for compliance with any hard and fast rule regarding the number of intermediate providers in the call flow.

- What is the right number of intermediate providers?

This question can be asked at two different levels. First, what is the right number of intermediate providers in any given call flow? Second, what is the right number of intermediate providers from the perspective of vendor management?

In terms of the number of providers in the call flow, the ATIS Handbook indicates that "[s]ome carriers have found it useful to limit intermediate providers to include no more than one additional provider (not including the terminating carrier) in the call."[50] Having many providers in the call flow can cause delay in the call set-up process as each provider processes the call through its routing algorithms to identify the optimal next-hop.[51] It can also complicate the process of trouble-shooting and resolution.[52] Finally, it may also increase the possibility of additional digital to analog conversion activity, which may impair call quality.[53]

On the other hand, the FCC reported that only two intermediate providers—AT&T and CenturyLink—certified to the FCC that they complied with the "safe harbor" provision under the FCC's data reporting and retention rules.[54] One of the key requirements of the safe harbor is that the intermediate provider certify that it "restricts by contract any intermediate provider to which a call is directed…from permitting more than one additional intermediate provider in the call path before the call reaches the terminating provider or terminating tandem."[55] And in the re-origination complaints Verizon investigated, two of which included at least three intermediate providers, the basis of the complaint was the change in calling party number, not call quality.

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[50] ATIS Handbook at §6.2.

[51] ATIS Handbook at §5.1.5 ("complicated routing arrangements can result in undesirable post dial delays").

[52] ATIS Handbook at §6.2 ("As the number of providers handling a call increases…[t]roubleshooting may also prove more difficult.").

[53] Exhibit B (Workshop I) at slides 8-9 ("Conversion from Analog (Native Voice) to Digital (Both IP and TDM) is performed by a CODEC – more than TWO conversions in a call flow will result in poor quality.").

[54] FCC Data Report ¶ 36.

[55] 47 CFR § 64.2107(a).

The demands of vendor management also bear on the optimal number of intermediate providers.[56] Managing and monitoring direct interconnection relationships with a few vendors is easier than with many. And placing limits or restrictions on the number of additional intermediate providers that may be used might give an originating provider some additional comfort regarding the number of potential additional "subcontractors" handling its traffic. Smaller service providers may not have the resources to manage multiple vendors or to keep track of downstream providers' performance. Larger service providers may have greater resources for doing so, and may prefer the flexibility that comes from having multiple choices.

Ultimately, each provider should have the flexibility to determine when and where to use intermediate providers, and how many to use, as long as it continues to provide appropriate levels of service in accordance with FCC requirements.

3. Managing Congestion from Auto-Dialer Traffic Associated with Public Service Calls

Verizon has seen several instances in which voice calls were used to deliver important public service announcements like school closings and weather-alerts. However, in multiple cases, the volume of those calls and the rapidity with which they were placed may have impaired completion of those calls and undermined the goal of notification.

- In September 2015, Verizon investigated an OCN with a Call Answer Rate of 34 percent on 16,320 calls. Verizon attributed the low Call Answer Rate, in part, to congestion in the destination network on August 22, 2015. On August 22, 2015, 3,041 calls were released back to Verizon with a cause code of 34 (no circuit available). Further analysis of the second event, on August 22, 2015, showed that the majority of the call attempts originated from a single telephone number associated with an alert system. Verizon contacted the RLEC, which confirmed that there was a circuit overload condition on August 22, 2015, that was caused by the alert system.

- In November 2016, Verizon investigated a Repeat-Attempt measure of roughly 25% for an individual rural LEC CLLI. The high Repeat Attempt rate was due to an auto-dialer event. During a 12 minute period on November 3, there were 3,383 calls from a single originating number. This caused congestion on the trunks into the RLEC end office resulting in 3,841 calls with cause code 34 (no circuit available). The single dialing number was associated with an alert system contracted by local governments to broadcast alert messages such as school closings.

- In May 2015, Verizon investigated an OCN with a Call Answer Rate of 33% on approximately 75,000 calls. Verizon attributed the low Call Answer Rate to 68,567 calls from one number that were made in a short time period. This number placing the calls belongs to a public service announcement system, which is an auto-dialer used by government agencies to launch recorded

[56] Exhibit B (Workshop I) at slide 58 (depicting how an initial set of 6 directly connected intermediate providers and 30 downstream providers can drive significant complexity).

> messages for issues such as school closings and weather-related emergencies. The majority of the uncompleted calls during this period received a cause code 34 (no circuit available) due to congestion on the circuits connecting the Rural LEC's end office switch to the tandem switch. This treatment occurred on calls completed via both onnet (direct termination by Verizon) and offnet (intermediate provider) facilities. Verizon's review of the called numbers indicates that many of the numbers likely were in service.

Providers typically engineer capacity into their networks in accordance with established industry practices. The P.01 grade of service is one standard in use in the industry.[57] The P.01 grade of service standard is loosely described as an attempt to ensure that no more than 1 call in a 100 is lost during the busy period.[58] Modern auto-dialer technology employed over Internet-protocol based calling platforms may be capable of generating call volumes far greater than what occurs during a normal busy period, and thus overwhelm existing capacity arrangements between provider networks. These events may occur infrequently enough to make it difficult for terminating carriers to justify expanding capacity to support their full traffic-generating potential and may occur too unpredictably to enable providers to respond with other traditional network management techniques. As suggested in the ATIS Handbook,

> *Terminating carriers may wish to identify entities that engage in this type of calling activity on a regular basis in their service territory, such as local school districts. The carrier may be able to work with the calling entity so that the calling activity is structured in a manner that reduces the likelihood for network congestion, for example, by spacing calls out to a greater degree; calling at different times, or rotating through called NPA-NXXs in a way that better distributes the calling load across the terminating carrier's network.*[59]

Similarly, an operator of such a calling service may find itself not effectively delivering the contracted-for service to its customer if the manner in which the calls are placed undermines deliverability.

[57] ATIS Handbook at §5.4.

[58] Exhibit B (Workshop I) at slide 29. ATIS Handbook at §5.4.2 ("Networks are normally designed to accommodate average business day customer calling patterns.").

[59] ATIS Handbook at §5.4.2.1.2.

IV Conclusion

Verizon's experience implementing the Consent Decree resulted in many valuable lessons learned with respect to monitoring and investigating rural call completion issues. Although Verizon did not identify or uncover any particular "silver bullet," the lessons learned, industry best practices, and other information described in this Report may prove useful to the FCC and to other providers that, like Verizon, are seeking additional efficiency in the process of identifying and investigating call completion issues.

EXHIBIT A

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Verizon	)	File No.: EB-IHD-14-00014821
	)	Acct. No.: 201532080007
	)	FRN: 0004335592
	)	
	)	

ADOPTING ORDER

Adopted: January 26, 2015 **Released: January 26, 2015**

By the Chief, Enforcement Bureau:

1. The Enforcement Bureau (Bureau) of the Federal Communications Commission has entered into a Consent Decree to resolve its investigation into Verizon's failure to investigate evidence it collected over an eight-month period that reflected potential problems with its delivery of calls to rural areas of the country. Rural call completion problems have significant and immediate public interest ramifications. They cause rural businesses to lose customers, impede medical professionals from reaching patients in rural areas, cut families off from their relatives, and create the potential for dangerous delays in public safety communications. To settle this matter, Verizon admits that it failed to investigate the cause of low call answer rates in 26 rural areas, and will pay a $2,000,000 fine. Prospectively, Verizon also will implement a compliance plan in which it will spend an additional $3,000,000 on measures to advance and achieve Company and industry solutions to rural call completion problems.

2. After reviewing the terms of the Consent Decree and evaluating the facts before us, we find that the public interest would be served by adopting the Consent Decree and terminating the referenced investigation[1] regarding Verizon's compliance with Sections 201(b) and 202(a) of the Communications Act of 1934, as amended[2] with respect to its investigation of its call completion to rural areas.

3. In the absence of material new evidence relating to this matter, we conclude that our investigation raises no substantial or material questions of fact as to whether Verizon possesses the basic qualifications, including those related to character, to hold or obtain any Commission license or authorization.

4. Accordingly, **IT IS ORDERED** that, pursuant to Section 4(i) of the Act[3] and the authority delegated by Sections 0.111 and 0.311 of the Rules,[4] the attached Consent Decree **IS ADOPTED** and its terms incorporated by reference.

5. **IT IS FURTHER ORDERED** that the above-captioned matter **IS TERMINATED**.

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[1] This investigation was initiated under File No. EB-IHD-13-00011647 and subsequently assigned File No. EB-IHD-14-00014821.

[2] 47 U.S.C. §§ 201(b), 202(a); *see also Developing an Unified Intercarrier Compensation Regime*, Declaratory Ruling, 27 FCC Rcd 1351 (Wireline Comp. Bur. 2012).

[3] 47 U.S.C. § 154(i).

[4] 47 C.F.R §§ 0.111, 0.311.

6. **IT IS FURTHER ORDERED** that a copy of this Order and Consent Decree shall be sent by first class mail and certified mail, return receipt requested, to Tamara Preiss, Vice President, Federal Regulatory Affairs, Verizon, 1300 I Street, NW, Suite 400 West, Washington, DC 20005.

FEDERAL COMMUNICATIONS COMMISSION

Travis LeBlanc
Chief
Enforcement Bureau

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Verizon	)	File No.: EB-IHD-14-00014821[1]
	)	Acct. No.: 201532080007
	)	FRN: 0004335592
	)	
	)	

CONSENT DECREE

1. The Enforcement Bureau of the Federal Communications Commission and Verizon, by their authorized representatives, hereby enter into this Consent Decree to resolve and terminate the Enforcement Bureau's investigation into whether Verizon violated Sections 201(b) and 202(a) of the Communications Act of 1934, as amended (Act),[2] in connection with evidence collected over an eight-month period that reflected potentially substandard delivery of long distance calls to certain rural areas.

I. DEFINITIONS

2. For the purposes of this Consent Decree, the following definitions[3] shall apply:

(a) "Act" means the Communications Act of 1934, as amended.[4]

(b) "Adopting Order" means an order of the Commission or the Bureau adopting the terms of this Consent Decree without change, addition, deletion, or modification.

(c) "Answered Call" means a call that receives an answer message and a normal release cause code (e.g., a release cause code of 16 or 31 for calls signaled with SS7 or the corresponding normal release codes for calls signaled with session initiation protocol (SIP)).

(d) "Attempted Call" means a call that results in transmission by Verizon toward an incumbent rural local exchange carrier of the initial call setup message, regardless of the voice call signaling and transmission technology used.

(e) "Aggregate Rural Answer Rate" means the Call Answer Rate for calls to all Rural OCNs.

(f) "Bureau" means the Enforcement Bureau of the Federal Communications Commission.

(g) "Call Answer Rate" means a rate calculated by dividing (1) total Answered Calls by (2) total Attempted Calls minus Attempted Calls to unassigned numbers as indicated

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[1] This investigation was initiated under File No. EB-IHD-13-00011647 and subsequently assigned File No. EB-IHD-14-00014821.

[2] *See* 47 U.S.C. §§ 201(b), 202(a); *see also Developing an Unified Intercarrier Compensation Regime*, Declaratory Ruling, 27 FCC Rcd 1351 (Wireline Comp. Bur. 2012) (*Rural Call Completion Declaratory Ruling*).

[3] The definitions herein are only for purposes of this Consent Decree and do not affect any definitions in any other Commission order or proceeding, including other matters dealing with rural call completion. As an example, the definition of "answered call" in this Consent Decree has no effect on and does not alter the definition of "answered call" in the *Rural Call Completion Order*.

[4] 47 U.S.C. § 151 *et seq.*

by the release cause code (e.g., a release cause code of 1 for calls signaled with SS7 or the corresponding release cause code for calls signaled with session initiation protocol).

(h) "Commission" and "FCC" mean the Federal Communications Commission and all of its bureaus and offices.

(i) "Communications Laws" means collectively, the Act, the Rules, and the published and promulgated orders and decisions of the Commission to which Verizon is subject by virtue of its business activities.

(j) "Compliance Plan" means the compliance obligations, program, and procedures described in this Consent Decree at paragraph 18.

(k) "Covered Employees" means all employees and agents of Verizon Business who perform, or supervise, oversee, or manage the performance of, duties directly related to Verizon's responsibilities under the Rural Call Completion Rules, including Sections 201(b) and 202(a) of the Act, as interpreted in the *Rural Call Completion Declaratory Ruling*.

(l) "Effective Date" means the date by which both the Bureau and Verizon have signed the Consent Decree.

(m) "Intermediate Provider" has the meaning provided in Section 64.1600(f) of the Rules,[5] but excludes a tandem provider to which the terminating carrier subtends or a carrier to which the terminating carrier requires an indirectly interconnecting carrier to deliver traffic.

(n) "Investigation" means the investigation commenced by the Bureau under File No. EB-IHD-13-00011647 regarding whether Verizon violated Sections 201(b) and 202(a) of the Act.

(o) "LOI" means the Letter of Inquiry issued by the Bureau to Verizon on February 3, 2014.

(p) "Negative Spike" means a sharp, material decrease from prior measurements over a short interval.

(q) "OCN" means an Operating Company Number that is an alphanumeric code that uniquely identifies providers of local telecommunications service.[6]

(r) "Operating Procedures" means the standard internal operating procedures and compliance policies established by Verizon to implement the Compliance Plan.

(s) "Parties" means Verizon and the Bureau, each of which is a "Party."

(t) "Rules" means the Commission's regulations found in Title 47 of the Code of Federal Regulations.

(u) "*Rural Call Completion Declaratory Ruling*" means the declaratory ruling captioned as *Developing an Unified Intercarrier Compensation Regime*, Declaratory Ruling, 27 FCC Rcd 1351 (Wireline Comp. Bur. 2012). "*Rural Call Completion Order*" means the order captioned as *Rural Call Completion,* Report and Order and Further Notice of Proposed Rulemaking, 28 FCC Rcd 16154 (2013), *modified in part on recon.,* Order on Reconsideration, FCC 14-175, 2014 WL 6070709 (rel. Nov. 13,

[5] 47 C.F.R. § 64.1600(f).

[6] *See* Alliance for Telecommunications Industry Solutions, *ATIS Telecom Glossary, available at* http://www.atis.org/glossary/definition.aspx?id=8448 (last accessed Dec. 22, 2014).

2014).

(v) "Rural Call Completion Rules" means Sections 201(b) and 202(a) of the Act, as interpreted in the *Rural Call Completion Declaratory Ruling*, and the rules adopted in the *Rural Call Completion Order*, 47 C.F.R. Sections 64.2101, 64.2103, 64.2105, 64.2107, 64.2109 and 64.2201, and other provisions of the Act, the Rules, and Commission orders related to Rural Call Completion.

(w) "Rural OCN" means an OCN that is designated as rural on the annually updated list published by the National Exchange Carrier Association (NECA), as described in the *Rural Call Completion Order*, 28 FCC Rcd at 16187, para. 73.

(x) "Verizon" or "Company" means MCI Communications Services, Inc. d/b/a Verizon Business Services ("Verizon Business").

(y) "Verizon and its regulated affiliates" means the regulated wholly owned subsidiaries of Verizon Communications Inc., including but not limited to Verizon Business, Cellco Partnership d/b/a Verizon Wireless ("Verizon Wireless"), and all affiliated incumbent local exchange carriers ("Verizon ILECs").

(z) "Verizon RLEC Hotline" means (800) 285-3776 (or an alternative similarly designated number), the toll free number established by Verizon for use by carriers to report rural calling issues.

II. BACKGROUND

3. Section 201(b) of the Act provides that "[a]ll charges, practices, classifications, and regulations for and in connection with [interstate and foreign] communication service, shall be just and reasonable, and any such charge, practice, classification, or regulation that is unjust or unreasonable is declared to be unlawful."[7] Section 202(a) states that "[i]t shall be unlawful for any common carrier to make any unjust or unreasonable discrimination in charges, practices, classifications, regulations, facilities, or services for or in connection with like communication service, directly or indirectly, by any means or device, . . . or to subject any particular person, class of persons, or locality to any undue or unreasonable prejudice or disadvantage."[8]

4. The Commission has emphasized that "it is vital that our Nation maintains a communications network that offers reliable and resilient service."[9] The Commission has also recognized that "permitting blocking or the refusal to deliver voice telephone traffic, whether as a means of 'self-help' to address perceived unreasonable intercarrier compensation charges or otherwise, risks 'degradation of the country's telecommunications network.'"[10] To prevent that result, the Commission

[7] 47 U.S.C. § 201(b).

[8] *Id.* § 202(a).

[9] *Reliability and Continuity of Communications Networks, Including Broadband Technologies*, Notice of Inquiry, 26 FCC Rcd 5614, 5616, para. 5 (2011); *see also Establishing Just and Reasonable Rates for Local Exchange Carriers*, Declaratory Ruling and Order, 22 FCC Rcd 11629, para. 1 (Wireline Comp. Bur. 2007) (explaining that "the ubiquity and reliability of the nation's telecommunications network is of paramount importance to the explicit goals of the Communications Act") (*Call Blocking Declaratory Ruling*).

[10] *Connect America Fund*, Report and Order and Further Notice of Proposed Rulemaking, 26 FCC Rcd 17663, 18029, para. 973 (2011), *aff'd sub nom. In re: FCC 11-161*, 753 F.3d 1015 (10th Cir. 2014) (quoting *Access Charge Reform*, Seventh Report and Order and Further Notice of Proposed Rulemaking, 16 FCC Rcd 9923, 9933, para. 24 (2001)) (footnotes omitted).

has consistently held that telecommunications carriers, including interexchange carriers, generally may not "'block, choke, reduce or restrict traffic in any way.'"[11]

5. In June 2011, a coalition of trade associations representing rural rate-of-return incumbent local exchange carriers (LECs) sent a letter to the Bureau concerning "a nationwide and industry-wide epidemic" of calls to rural LEC service areas failing to complete or having poor call quality.[12] In September 2011, the Commission announced that it had created a Rural Call Completion Task Force "to investigate and address the growing problem of calls to rural customers that are being delayed or that fail to connect."[13]

6. On February 6, 2012, the Commission's Wireline Competition Bureau (WCB) issued the *Rural Call Completion Declaratory Ruling*, which "clarif[ied] that a carrier that knows or should know that calls are not being completed to certain areas, and that engages in acts (or omissions) that allow or effectively allow these conditions to persist, may be liable for a violation of section 201 of the Act."[14] It found that "it is an unjust and unreasonable practice in violation of section 201 of the Act for a carrier that knows or should know that it is providing degraded service to certain areas to fail to correct the problem or to fail to ensure that intermediate providers, least-cost routers, or other entities acting for or employed by the carrier are performing adequately."[15] WCB further clarified that "adopting or perpetuating routing practices that result in lower quality service to rural or high-cost localities than like service to urban or lower cost localities (including other lower cost rural areas) may, in the absence of a persuasive explanation, constitute unjust or unreasonable discrimination in practices, facilities, or services and violate section 202 of the Act."[16]

7. On November 8, 2013, the Commission released the *Rural Call Completion Order*, which adopted rules requiring covered providers to record, retain, and report to the Commission call answer rates for long-distance calls.[17] The Commission found that "rural call completion problems are serious and widespread,"[18] and that "[t]hese failures have significant and immediate public interest ramifications, causing rural businesses to lose customers, cutting families off from their relatives in rural areas, and creating potential for dangerous delays in public safety communications in rural areas."[19] The new rules require "covered providers"[20] to record and retain detailed information about long-distance calls

[11] *Id.* at 17903, para. 734 (quoting *Call Blocking Declaratory Ruling*, 22 FCC Rcd at 11631, para. 6). The Commission has permitted call blocking "only under rare and limited circumstances." *See Call Blocking Declaratory Ruling*, 22 FCC Rcd at 11631, para. 6 n.20.

[12] Letter from Michael Romano, National Telecommunications Cooperative Association, *et al.*, to Theresa Z. Cavanaugh, Acting Chief, Investigations & Hearings Division, FCC Enforcement Bureau, and Margaret Dailey, Attorney Advisor, Investigations & Hearings Division, FCC Enforcement Bureau at 3 (June 13, 2011).

[13] *FCC Launches Rural Call Completion Task Force to Address Call Routing and Termination Problems in Rural America*, News Release, 2011 WL 4454097 (Sept. 26, 2011), *available at* http://www.fcc.gov/document/fcc-launches-rural-call-completion-task-force-sets-oct-18-workshop. The Task Force conducted a workshop on rural call completion issues on October 18, 2011. *See* http://www.fcc.gov/events/rural-call-completion-workshop.

[14] *Rural Call Completion Declaratory Ruling*, 27 FCC Rcd at 1355, para. 11.

[15] *Id.* at 1355–56, para. 12 (footnote omitted).

[16] *Id.* at 1357–58, para. 14.

[17] *See Rural Call Completion Order*, 28 FCC Rcd at 16211–14, Appendix A.

[18] *Id.* at 16161, para. 14.

[19] *Id.* at 16155, para. 1.

[20] "Covered provider" means "a provider of long-distance voice service that makes the initial long-distance call path choice for more than 100,000 domestic retail subscriber lines." *See id.* at 16165, 16211, para. 20, Appendix A § 64.2101(c).

to customers of incumbent rural LECs,[21] identified by OCN. The rules also require covered providers to report to the Commission, on a quarterly basis, answer rates and call completion rates for long-distance calls delivered to each rural OCN and answer rates and call completion rates for long-distance calls delivered to non-rural OCNs in the aggregate.[22] The information collections required by the *Rural Call Completion Order* will go into effect after the Office of Management and Budget approves the information collections and the Commission publishes a notice in the Federal Register announcing their effective date(s).[23]

8. In its 2014 *Rural Call Completion Reconsideration Order*, the Commission stated that a failure "to investigate evidence of a rural call delivery problem or to correct a problem of degraded service about which [a carrier] knows or should know ... may lead to enforcement action."[24]

9. Verizon and its affiliates are among the world's leading providers of communications. Verizon and its wireline affiliates provide retail and wholesale local and long distance voice services to customers and carriers, including to their wireless affiliate, Verizon Wireless, as well as to businesses and government customers.

10. In April 2013, Verizon began to collect weekly samples of its call answer rates to individual rural incumbent LECs, identified by OCN.[25] These samples captured, for Wednesday of each week, all retail and wholesale traffic handled by Verizon's TDM (Time Division Multiplex)

> long distance networks [that was] destined to wireline local exchange carriers in rural areas. The data indicate the number of calls attempted to each rural destination and whether or not the call was answered, based on whether an SS7 Answer Message was generated for the call.[26]

Verizon collected this information for each Wednesday between April 24 and December 25, 2013 and periodically provided its weekly reports to the Enforcement Bureau.[27]

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[21] The Commission concluded that "the only call attempts that need to be retained are those to incumbent LECs that are rural telephone companies" because "rural call completion problems are largely confined to such carriers." *Id.* at 16177–78, para. 49; *see also* 47 U.S.C. § 153(44).

[22] *Rural Call Completion Order*, 28 FCC Rcd at 16184, para. 65.

[23] *Id.* at 16207, para. 131.

[24] *Rural Call Completion Reconsideration Order*, 2014 WL 6070709, at *11, para. 38 (citing *2012 Declaratory Ruling*, 27 FCC Rcd at 1355-56, 1358-59, paras. 12, 16).

[25] The rural OCNs identified in Verizon's reports were originally based on a list created by Verizon using a methodology devised by the Commission. Subsequently, NECA published a list of rural OCNs, *see Wireline Competition Bureau Announces Deadline for Comments on Rural Call Completion Notice of Proposed Rulemaking, Invites Comment on List of Rural Operating Carrier Numbers*, Public Notice, 28 FCC Rcd 5190 (Wireline Comp. Bur. 2013), and, as of July 1, 2014, Verizon began using the NECA OCN list for its weekly reports. *See* Letter from Tamara Preiss, Vice President, Federal Regulatory Affairs, Verizon, to Christopher Killion, Associate Chief, FCC Enforcement Bureau at 1 (Aug. 19, 2013) (on file in EB-IHD-14-0014821) (Verizon Aug. 19 Letter). The 26 rural OCNs addressed here appear on both lists.

[26] *See* Verizon Aug. 19 Letter; *see also* E-mail from Tamara Preiss, Verizon, to Margaret Dailey, Investigations & Hearings Division, FCC Enforcement Bureau (June 6, 2013) (on file in EB-IHD-14-00014821).

[27] *See* E-mail from Tamara Preiss, Verizon, to Christopher Killion, FCC Enforcement Bureau (Jan. 17, 2014) (on file in EB-IHD-14-00014821) (enclosing reports for October – December 2013); Letter from Tamara Preiss, Verizon, to Christopher Killion, FCC Enforcement Bureau (Nov. 8, 2013) (on file in EB-IHD-14-00014821) (enclosing reports for April 24, May 1, 8, 15, and 22, and September 2013); Letter from Tamara Preiss, Verizon, to Christopher Killion, FCC Enforcement Bureau (Sept. 30, 2013) (on file in EB-IHD-14-00014821) (enclosing reports for August 2013); Verizon August 19 Letter (enclosing reports for July 2013); Letter from Tamara Preiss, Verizon, (continued....)

11. After reviewing all of Verizon's reports for 2013, the Bureau issued a letter of inquiry (LOI) to Verizon seeking information about what efforts Verizon had made to investigate the causes of its persistently low call answer rates in 39 specific rural OCNs.[28] In its April 4, 2014 response to the LOI, Verizon acknowledged that, although it had previously initiated investigations or taken remedial action for 13 of the 39 OCNs, it had not done so for the remaining 26 OCNs prior to being served with the LOI.[29] Verizon did undertake an investigation of the remaining 26 OCNs after receiving the LOI and provided the results to the Bureau showing that, in Verizon's estimation, the low call answer rates were not attributable to Verizon's network or call completion practices.

III. TERMS OF AGREEMENT

12. **Adopting Order**. The provisions of this Consent Decree shall be incorporated by the Commission or the Bureau in an Adopting Order without change, addition, deletion, or modification.

13. **Jurisdiction**. Verizon agrees that the Commission, acting through the Bureau, has jurisdiction over it and the matters contained in this Consent Decree and has the authority to enter into and adopt this Consent Decree.

14. **Effective Date; Violations**. The Parties agree that this Consent Decree shall become effective on the Effective Date as defined herein. As of the Effective Date, the Parties agree that this Consent Decree shall have the same force and effect as any other order of the Commission.

15. **Termination of Investigation**. In express reliance on the covenants and representations in this Consent Decree and to avoid further expenditure of public resources, the Bureau agrees to terminate the Investigation of Verizon and its regulated affiliates. In consideration for the termination of the Investigation, Verizon agrees to the terms, conditions, and procedures contained herein. The Bureau further agrees that, in the absence of new material evidence, it will not use the facts developed in the Investigation through the Effective Date, or the existence of this Consent Decree, to institute any new proceeding, formal or informal, or take any action against Verizon and its regulated affiliates concerning the matters that were the subject of the Investigation. The Bureau also agrees that, in the absence of new material evidence, it will not use the facts developed in the Investigation through the Effective Date, or the existence of this Consent Decree, to institute any proceeding, formal or informal, or take any action against Verizon and its regulated affiliates with respect to their basic qualifications, including character qualifications, to be a Commission licensee or hold Commission licenses or authorizations.

16. **Admissions**. Verizon admits for the purpose of this Consent Decree and in express reliance on the provisions of paragraph 15 herein, that its call answer rates for the 39 OCNs were substantially below its call answer rates to other rural areas, and that it investigated the cause of the low call answer rates or took remedial action prior to receipt of the LOI for 13 of these OCNs but did not do so for the remaining 26 OCNs. Verizon did undertake an investigation of the remaining 26 OCNs after receiving the LOI and provided the results to the Bureau showing that, in Verizon's estimation, the low call answer rates were not attributable to Verizon's network or call completion practices.

17. **Compliance Officer**. Within thirty (30) calendar days after the Effective Date, Verizon shall designate a vice president who will have oversight over rural call completion matters for Verizon and its regulated affiliates to serve as a Compliance Officer and to discharge the duties set forth below.

(Continued from previous page)
to Margaret Dailey, Enforcement Bureau (July 19, 2013) (on file in EB-IHD-14-00014821) (enclosing reports for June 2013). Verizon did not provide the FCC with its records for May 29, 2013.

[28] Letter from Theresa Cavanaugh, Chief, Investigations & Hearings Division, FCC Enforcement Bureau, to Christopher M. Miller, Assistant General Counsel, Verizon Communications Inc. (Feb. 3, 2014) (on file in EB-IHD-14-00014821) (LOI).

[29] *See generally* Letter from Mark Montano, Assistant General Counsel, Verizon, to Marlene Dortch, Secretary, FCC (April 4, 2014) (on file in EB-IHD-14-00014821).

The Compliance Officer shall be the Company's Rural Call Completion Ombudsperson and shall be responsible for developing, implementing, and administering the Compliance Plan, and for ensuring that Verizon complies with the terms and conditions of the Compliance Plan and this Consent Decree, including the investigation and resolution of rural call completion issues. In addition to the general knowledge of the Communications Laws necessary to discharge his or her duties under this Consent Decree, the Compliance Officer shall have specific knowledge of Sections 201(b) and 202(a) of the Act, as interpreted in the *Rural Call Completion Declaratory Ruling*, and the *Rural Call Completion Rules*, prior to assuming his/her duties.

18. **Compliance Plan**. For purposes of settling the matters set forth herein, Verizon agrees that it shall, within ninety (90) calendar days after the Effective Date, develop and implement a Compliance Plan designed to ensure future compliance with the Rural Call Completion Rules and with the terms and conditions of this Consent Decree. Except as otherwise provided below, the Compliance Plan and these subparts shall be adopted by and apply only to Verizon as defined in paragraph I(2)(x).

(a) With respect to the Rural Call Completion Rules, Verizon will implement, at a minimum, the following procedures:

- **[1] Operating Procedures**. Within ninety (90) calendar days after the Effective Date, Verizon shall establish Operating Procedures that all Covered Employees must follow to help ensure Verizon's compliance with the Rural Call Completion Rules and this Consent Decree. Verizon's Operating Procedures shall include internal procedures and policies specifically designed to ensure that Verizon will timely investigate evidence of potential rural call completion problems about which it knows or should know, as further described below, and, if its investigation reveals a rural call completion problem, that Verizon will take appropriate steps to attempt to resolve the problem. Verizon shall also develop a Compliance Checklist that describes the steps that a Covered Employee must follow to ensure compliance with the Rural Call Completion Rules.

- **[2] Investigations**. Within ninety (90) calendar days after the Effective Date, Verizon shall commence monthly investigations of potential rural call completion problems using the metrics-driven approaches described below based on data from Verizon's three long distance networks (which formed the basis of Verizon's previous data reporting to the Bureau). Verizon will investigate its call delivery to 20 Rural OCNs per month unless certain conditions are met, as described below.

  A. Monthly Investigations: Verizon shall investigate its call delivery to up to 20 Rural OCNs for which its Call Answer Rate fell below 80% of its Aggregate Rural Answer Rate in the prior month. If Verizon's Call Answer Rate falls below 80% of the Aggregate Rural Answer Rate in 20 or more Rural OCNs for any month, Verizon will investigate up to 20 Rural OCNs, which will include the OCNs with the lowest Call Answer Rates during the prior month but exclude OCNs it investigated within the prior two months.

  B. Negative Spike Investigations: Within 30 days of the Effective Date, Verizon shall establish a metric, subject to approval by the Bureau, to identify Negative Spikes in Call Answer Rates to individual Rural OCNs in order to capture sudden decreases and short material disruptions in the Call Answer Rate to a Rural OCN, which the monthly investigation process might not otherwise flag for prompt investigation. Verizon shall investigate up to ten (10) "Negative Spike OCNs" per month. Each Negative Spike OCN investigation shall reduce (from 20) the number of monthly investigations that Verizon is required to conduct each month. Verizon shall implement the Negative Spike OCN investigation process

as soon as possible following implementation of the monthly investigation process but no later than 120 days from the Bureau's approval of the metric.

C. Complaint Investigation Process: Verizon shall continue its current practice of investigating rural call completion complaints that it receives from the FCC, its RLEC Hotline, customers, rural consumers, or other sources. These investigations shall not count toward the 20 monthly or Negative Spike investigations described in paragraphs A and B above.

D. Investigation Checklist: Verizon's investigations, which shall be similar to its investigations of the Rural OCNs conducted in response to the LOI, shall include one or more of the following, depending on the scope and nature of information observed and identified during the course of the investigation:

- Contact with the rural LEC, tandem provider, and/or Intermediate Provider;
- Performance of milliwatt testing;
- Placement of manual test calls, including to previously unanswered numbers, utilizing SS7 call trace equipment to monitor the exchange of signaling information in real time and to confirm signaling messages were coming from the rural LEC or a tandem provider and not an Intermediate Provider;
- Review of routing arrangements, trunk capacity, and network translations;
- Consultation with Verizon's fraud group to analyze traffic patterns that may reflect potential call reorigination or other fraudulent behavior;
- Review by Verizon network engineering personnel of call detail records, release cause codes, or other traffic data for the OCN, or switch and trunk data for the Verizon network; and
- Inquiry into whether other factors (*e.g.*, prevalence of lines with answering technology such as voicemail, or autodialer traffic, or relative proportion of unassigned numbers) are relevant.

E. To the extent Verizon does not already have contact information, Verizon shall consult the Local Exchange Routing Guide (LERG) for rural LEC contact information. In the absence of LERG contact information, Verizon will seek contact information using the rural LEC's web site, the FCC's Form 499 database, the NECA Tariff FCC No. 5, or other available resources.

F. If an investigation reveals a possible problem with the rural LEC's network or call signaling practices, Verizon will promptly notify the rural LEC and request troubleshooting and correction.

G. Verizon will remove from routing any Intermediate Provider that it uses that it has reason to believe is causing call completion problems, or will work cooperatively with each such Intermediate Provider to analyze and resolve such problems as soon as practicable.

- **[3] Investigative Logs; Quarterly Reports; Meetings.** Verizon shall keep logs of its investigative and notification efforts and provide quarterly summaries to the

Bureau. The summaries shall specify, by individual investigated Rural OCN, the Investigative Checklist methods employed by Verizon and explain why the chosen investigative methods were appropriate for the individual Rural OCN. At the Bureau's request, Verizon will meet to discuss its investigations, identify lessons learned, and address whether to employ different or additional investigative methods going forward.

- [4] **Adjustment of Investigation Metrics.** After six months of investigations are complete, Verizon or the Bureau may periodically propose changes to the metrics or triggers used to identify Rural OCNs for investigation, and will consider whether the maximum number of Negative Spike investigations should be altered. Subject to approval of the other Party, which will not be unreasonably withheld after consultation between the Parties, adjustments to the metrics, triggers, or maximum number of Negative Spike Investigations may be implemented.

- [5] **Steps to Limit Verizon's Use of Intermediate Providers.** Within six months of the Effective Date, for traffic from any of Verizon's long distance networks that is destined for Rural OCNs, Verizon shall limit its use of Intermediate Providers in the following manner: Verizon will route such traffic through Intermediate Providers only if the initial Intermediate Provider to which Verizon has delivered the traffic has committed to terminate traffic to the rural LEC (or the tandem switch that the rural LEC's switch subtends) through direct connections ("onnet") or through no more than one additional Intermediate Provider. For purposes of this provision, any Intermediate Provider's use of overflow arrangements (by which an Intermediate Provider's traffic is routed to another provider's network in the event of network outages or congestion) shall not be deemed to violate the requirements set forth in this paragraph. Verizon will seek agreement from each of its Intermediate Providers to provide a quarterly estimate of the percentage of that provider's traffic that is routed through overflow arrangements, provided however that it is not a violation of this Consent Decree if Verizon does not obtain such agreement. Inadvertent routing of a non-material amount of traffic to Intermediate Providers other than as set forth above shall not constitute a violation of this section provided that Verizon corrects any such situation promptly upon learning of it. Verizon shall retain the option to adopt the FCC's safe harbor with respect to use of Intermediate Providers as an alternative way to satisfy this provision.[30]

- [6] **Intake Identification and Special Handling of Rural Call Completion Problems.** Within six months of the Effective Date, Verizon shall implement changes to its internal systems for customer complaint intake and handling that will result in the automatic flagging of issues related to rural call completion. Specifically, Verizon's IT systems will compare the NPA-NXX of the "dialed-to" number contained in the complaint to the LERG database and will flag rural LEC issues for special handling pursuant to the Operating Procedures. This provision shall apply to both Verizon and the Verizon ILECs.

- [7] **Compliance Manual.** Within ninety (90) calendar days after the Effective Date, the Compliance Officer shall develop and distribute a Compliance Manual to all Covered Employees. The Compliance Manual shall explain the Rural Call Completion Rules and set forth the Operating Procedures that Covered Employees shall follow to help ensure Verizon's compliance with the Rural Call Completion Rules and this Consent Decree. Verizon shall periodically review and revise the Compliance Manual as necessary to ensure that the information set forth therein

[30] *See Rural Call Completion Order*, 28 FCC Rcd at 16191-94, 16213, paras. 86-94, Appendix A §64.2107.

remains current and accurate. Verizon shall distribute any revisions to the Compliance Manual promptly to all Covered Employees.

- [8] **Compliance Training Program**. Verizon shall establish and implement a Compliance Training Program on compliance with the Rural Call Completion Rules and the Operating Procedures. As part of the Compliance Training Program, Covered Employees shall be advised of Verizon's obligation to report any material noncompliance with the Rural Call Completion Rules under paragraph 19 of this Consent Decree and shall be instructed on how to disclose noncompliance to the Compliance Officer. All Covered Employees shall be trained pursuant to the Compliance Training Program within ninety (90) calendar days after the Effective Date, except that any person who becomes a Covered Employee at any time after the initial Compliance Training Program shall be trained within sixty (60) calendar days after the date such person becomes a Covered Employee. Verizon shall repeat compliance training on an annual basis, and shall periodically review and revise the Compliance Training Program as necessary to ensure that it remains current and complete and to enhance its effectiveness.

(b) **Industry Engagement**. Verizon commits to undertake the following efforts to advance an industry solution to rural call completion problems:

- [1] **Workshops.** Verizon shall organize, fund and host two workshops. Workshop 1 will be held in in the Washington, DC metro area within six months of the Effective Date to discuss methods to further identify and isolate the causes of, and to develop strategies to avoid, detect, and resolve rural call completion problems. Workshop 2 will be held in the Washington, DC metro area approximately two years after Workshop 1 and will address the current state of rural call completion, notable successes, and continued challenges since the first Workshop.
    - Verizon shall coordinate the organization, publicizing, and planning for the Workshops with rural representatives, including NTCA and NECA. In addition, Verizon will invite representatives of the relevant industry segments, including long distance and wireless providers, rural LECs, intermediate providers, relevant trade associations, such as USTelecom, CTIA, and COMPTEL, and relevant government agencies, including the FCC to both Workshops. Each Workshop will include participants with technical expertise relevant to rural call completion issues.
    - Verizon shall bear all costs of the venue and publicizing of Workshops 1 and 2.
- [2] **Research**. Verizon shall commission a grant in the amount of $30,000-$50,000 for an academic study on methods to detect and resolve rural call completion problems in real time.
    - Verizon shall publicize the grant within three months of the Effective Date and will select the winning proposal, following consultation with the Bureau, within 45 days after Workshop 1.
    - Verizon agrees to work with the grantee and the Bureau to provide reasonable access, consistent with all legal obligations, to traffic data, if necessary, for the academic study.
    - The academic study shall be required to be completed within 18 months of the selection and the grantee shall be required to present his or her findings to Verizon and the Bureau, as well as at Workshop 2.

- **[3] Communication**. Verizon will work with NECA, NTCA, and other rural representatives to publicize to the rural LEC community the Verizon RLEC Hotline, the availability of milliwatt testing, and the importance of maintaining updated contact information in the LERG.
    - In addition, Verizon shall maintain a list of contact information (*e.g.*, phone numbers, e-mail addresses) for each rural LEC that it contacts during its investigations and will share with the FCC the contact information for rural LECs and other providers that it obtains through its investigations.
- **[4] Public Report.** Verizon shall prepare a Public Report summarizing its investigations, lessons learned, and other information regarding avoidance, investigation, and resolution of rural call completion problems, including information presented in Workshop 2. Verizon will share a draft of the report with the Bureau and work with the Bureau to prepare a final public version to be filed in WCB Docket No. 13-39 within 90 days of the Termination Date.

19. **Reporting Noncompliance**. Verizon shall report any material noncompliance with the Rural Call Completion Rules and with the terms and conditions of this Consent Decree within fifteen (15) business days after discovery of such noncompliance. Such reports shall include a detailed explanation of: (i) each instance of material noncompliance; (ii) the steps that Verizon has taken or will take to remedy such noncompliance; (iii) the schedule on which such remedial actions will be taken; and (iv) the steps that Verizon has taken or will take to prevent the recurrence of any such noncompliance. All reports of noncompliance shall be submitted to the Chief, Investigations and Hearings Division, Enforcement Bureau, Federal Communications Commission, 445 12th Street, SW, Room 4-C224, Washington, DC 20554, with a copy submitted electronically to Jeffrey Gee at Jeffrey.Gee@fcc.gov and Margaret Dailey at Margaret.Dailey@fcc.gov.

20. **Compliance Reports**. Verizon shall file compliance reports with the Commission 120 calendar days after the Effective Date, twelve (12) months after the Effective Date, twenty-four (24) months after the Effective Date, and thirty-six (36) months after the Effective Date.

(a) Each Compliance Report shall include a detailed description of Verizon's efforts during the relevant period to comply with the terms and conditions of this Consent Decree and the Rural Call Completion Rules. In addition, each Compliance Report shall include a certification by the Compliance Officer, as an agent of and on behalf of Verizon, stating that the Compliance Officer has personal knowledge that Verizon: (i) has established and implemented the Compliance Plan; (ii) has utilized the Operating Procedures since the implementation of the Compliance Plan; and (iii) is not aware of any instances of material noncompliance with the terms and conditions of this Consent Decree, including the reporting obligations set forth in paragraph 19 of this Consent Decree.

(b) The Compliance Officer's certification shall be accompanied by a statement explaining the basis for such certification and shall comply with Section 1.16 of the Rules and be subscribed to as true under penalty of perjury in substantially the form set forth therein.[31]

(c) If the Compliance Officer cannot provide the requisite certification, the Compliance Officer, as an agent of and on behalf of Verizon, shall provide the Commission with a detailed explanation of the reason(s) why and describe fully: (i) each instance of material noncompliance; (ii) the steps that Verizon has taken or will take to remedy

[31] 47 C.F.R. § 1.16.

such noncompliance, including the schedule on which proposed remedial actions will be taken; and (iii) the steps that Verizon has taken or will take to prevent the recurrence of any such noncompliance, including the schedule on which such preventive action will be taken.

(d) All Compliance Reports shall be submitted to the Chief, Investigations and Hearings Division, Enforcement Bureau, Federal Communications Commission, 445 12th Street, SW, Room 4-C224, Washington, DC 20554, with a copy submitted electronically to Jeffrey Gee at Jeffrey.Gee@fcc.gov and Margaret Dailey at Margaret.Dailey@fcc.gov.

21. **Termination Date**. Unless stated otherwise, the requirements set forth in paragraphs 17 through 20 of this Consent Decree shall expire thirty-six (36) months after the Effective Date.

22. **Section 208 Complaints; Subsequent Investigations**. Nothing in this Consent Decree shall prevent the Commission or its delegated authority from adjudicating complaints filed pursuant to Section 208 of the Act[32] against Verizon or its affiliates for alleged violations of the Act, or for any other type of alleged misconduct, regardless of when such misconduct took place. The Commission's adjudication of any such complaint will be based solely on the record developed in that proceeding. Except as expressly provided in this Consent Decree, this Consent Decree shall not prevent the Commission from investigating new evidence of noncompliance by Verizon with the Communications Laws.

23. **Compliance with the *Rural Call Completion Order* and FCC Rules**. Nothing in this Consent Decree shall alter Verizon's obligation to comply with the *Rural Call Completion Order* or any other FCC Rules or orders.

24. **Fine**. Verizon will pay a fine to the United States Treasury in the amount of Two Million Dollars ($2,000,000) within thirty (30) calendar days of the Effective Date. Verizon shall send electronic notification of payment to Jeffrey Gee at Jeffrey.Gee@fcc.gov and Margaret Dailey at Margaret.Dailey@fcc.gov on the date said payment is made. The payment must be made by check or similar instrument, wire transfer, or credit card, and must include the Account Number and FRN referenced above. Regardless of the form of payment, a completed FCC Form 159 (Remittance Advice) must be submitted.[33] When completing the FCC Form 159, enter the Account Number in block number 23A (call sign/other ID) and enter the letters "FORF" in block number 24A (payment type code). Below are additional instructions that should be followed based on the form of payment selected:

- Payment by check or money order must be made payable to the order of the Federal Communications Commission. Such payments (along with the completed Form 159) must be mailed to Federal Communications Commission, P.O. Box 979088, St. Louis, MO 63197-9000, or sent via overnight mail to U.S. Bank – Government Lockbox #979088, SL-MO-C2-GL, 1005 Convention Plaza, St. Louis, MO 63101.
- Payment by wire transfer must be made to ABA Number 021030004, receiving bank TREAS/NYC, and Account Number 27000001. To complete the wire transfer and ensure appropriate crediting of the wired funds, a completed Form 159 must be faxed to U.S. Bank at (314) 418-4232 on the same business day the wire transfer is initiated.
- Payment by credit card must be made by providing the required credit card information on FCC Form 159 and signing and dating the Form 159 to authorize the credit card payment. The completed Form 159 must then be mailed to Federal Communications Commission, P.O. Box 979088, St. Louis, MO 63197-9000, or sent via overnight mail to U.S. Bank –

[32] 47 U.S.C. § 208.

[33] An FCC Form 159 and detailed instructions for completing the form may be obtained at http://www.fcc.gov/forms#159.pdf.

Government Lockbox #979088, SL-MO-C2-GL, 1005 Convention Plaza, St. Louis, MO 63101.

Questions regarding payment procedures should be addressed to the Financial Operations Group Help Desk by phone, 1-877-480-3201, or by e-mail, ARINQUIRIES@fcc.gov.

25. **Additional Financial Commitment.** In furtherance of this comprehensive settlement, and in addition to the fine specified in paragraph 24 above, Verizon commits to have spent prior to the Termination Date of this Consent Decree, at least Three Million Dollars ($3,000,000) on measures to advance and achieve Company and industry solutions to rural call completion problems, including through the measures specified in paragraph 18 above. This Three Million Dollar rural call completion commitment is separate from and in addition to any expenditures Verizon otherwise would have made to comply with the *Rural Call Completion Order* and does not include expenses incurred responding to the LOI. Verizon will provide an overview of amounts spent for these purposes in its annual compliance reports to the Bureau.

26. **Waivers**. As of the Effective Date, Verizon waives any and all rights it may have to seek administrative or judicial reconsideration, review, appeal or stay, or to otherwise challenge or contest the validity of this Consent Decree and the Adopting Order. Verizon shall retain the right to challenge Commission interpretation of the Consent Decree or any terms contained herein. If either Party (or the United States on behalf of the Commission) brings a judicial action to enforce the terms of the Consent Decree or the Adopting Order, neither Verizon nor the Commission shall contest the validity of the Consent Decree or the Adopting Order, and Verizon shall waive any statutory right to a trial *de novo*. Verizon hereby agrees to waive any claims it may otherwise have under the Equal Access to Justice Act[34] relating to the matters addressed in this Consent Decree.

27. **Severability**. The Parties agree that if any of the provisions of the Consent Decree shall be held unenforceable by any court of competent jurisdiction, such unenforceability shall not render unenforceable the entire Consent Decree, but rather the entire Consent Decree shall be construed as if not containing the particular unenforceable provision or provisions, and the rights and obligations of the Parties shall be construed and enforced accordingly.

28. **Invalidity**. In the event that this Consent Decree in its entirety is rendered invalid by any court of competent jurisdiction, it shall become null and void and may not be used in any manner in any legal proceeding.

29. **Subsequent Rule or Order**. The Parties agree that if any provision of the Consent Decree conflicts with any subsequent Rule or Order adopted by the Commission (except an Order specifically intended to revise the terms of this Consent Decree to which Verizon does not expressly consent) that provision will be superseded by such Rule or Order.

30. **Successors and Assigns**. Verizon agrees that the provisions of this Consent Decree shall be binding on its successors, assigns, and transferees.

31. **Final Settlement**. The Parties agree and acknowledge that this Consent Decree shall constitute a final settlement between the Parties with respect to the Investigation.

32. **Modifications**. This Consent Decree cannot be modified without the advance written consent of both Parties.

33. **Paragraph Headings**. The headings of the paragraphs in this Consent Decree are inserted for convenience only and are not intended to affect the meaning or interpretation of this Consent Decree.

34. **Authorized Representative**. Each Party represents and warrants to the other that it has full power and authority to enter into this Consent Decree. Each person signing this Consent Decree on

[34] *See* 5 U.S.C. § 504; 47 C.F.R. §§ 1.1501–1.1530.

behalf of a Party hereby represents that he or she is fully authorized by the Party to execute this Consent Decree and to bind the Party to its terms and conditions.

35. **Counterparts**. This Consent Decree may be signed in counterpart (including electronically or by facsimile). Each counterpart, when executed and delivered, shall be an original, and all of the counterparts together shall constitute one and the same fully executed instrument.

Travis LeBlanc
Chief
Enforcement Bureau

January 26, 2015
Date

Chris Miller
Vice President & Associate General Counsel
Verizon

January 21, 2015
Date

EXHIBIT B

EXHIBIT B

RURAL CALL COMPLETION INDUSTRY WORKSHOP

APRIL 22, 2015

NATIONAL PRESS CLUB
WASHINGTON, DC

Moderator

Introductory Note:

We would like to thank our panelists and the many others who assisted in preparing and delivering this workshop.

Please note that our panelists are here in their individual capacity, and the views expressed do not necessarily reflect the views of their respective employers, members, other panelists, or the workshop sponsor.

We welcome questions from the audience during the Q&A portion at the end of each panel.

EXHIBIT B

Panelist Roster – Panel 1

Moderators

Panel 1

Discussion of Technical Causes of Rural Call Completion Issues

Doug Davis	Hypercube
David Frankel	ZIP DX
Lee VonGunten	Craigville Telephone Company
Fritz Hendricks	Onvoy
Matthew Ottey	Verizon
Penn Pfautz	AT&T
Greg Harris	Verizon ***Moderator***

Panel Discussions

Panel 1
Discussion of Technical Causes of Rural Call Completion Issues

- PSTN is constantly changing
  Matt Ottey / Fritz Hendricks
- Trouble-shooting call complaints requires prompt action by multiple parties
  David Frankel / Matt Ottey
- Incentives for financial arbitrage
  Lee VonGunten / Fritz Hendricks / Doug Davis
- Catastrophic rural failures versus normal fluctuations in call completion and the role of unmanaged LCR
  Penn Pfautz
- Technical root causes of call completion issues
  David Frankel / Matt Ottey

PSTN is constantly changing

EXHIBIT B

Matt Ottey

PSTN is constantly changing

- Networks are constantly changing; new hardware; new software; maintenance activity.
- Industry arrangements are constantly changing; interconnection (LERG updates); number portability; new carriers and new services (VoIP, follow-me, find-me)
- Traffic patterns are constantly changing; auto-dialer activity; mass calling events; roaming; Wi-Fi-to-CMRS handoffs
- Traffic routing is constantly changing; avoiding outages or capacity constraints; optimizing network connectivity.

EXHIBIT B

Call Termination Issues – Quick Refresher

Fritz Hendricks

There are three types of Call Termination issues plaguing our industry

- Originating caller number changed from Intra to Inter State – far end consumer does not accept call because the originating number is not recognized
- Ring No Answer - Originating carrier signals ring back to their consumer, when in fact the call has not been offered to the far end consumer [2,3]
  - Two typical scenarios:
    - Call is never offered to the far end consumer
    - Call is delivered to the far end user after 9 to 10 rings
    - Caller ID is changed and/or zero'd
- Poor call quality – **(Manage this separately from Call Termination Issues)**

[2] Originating carriers should not signal to the originating consumer that a call is in progress until the far end device has been offered the call

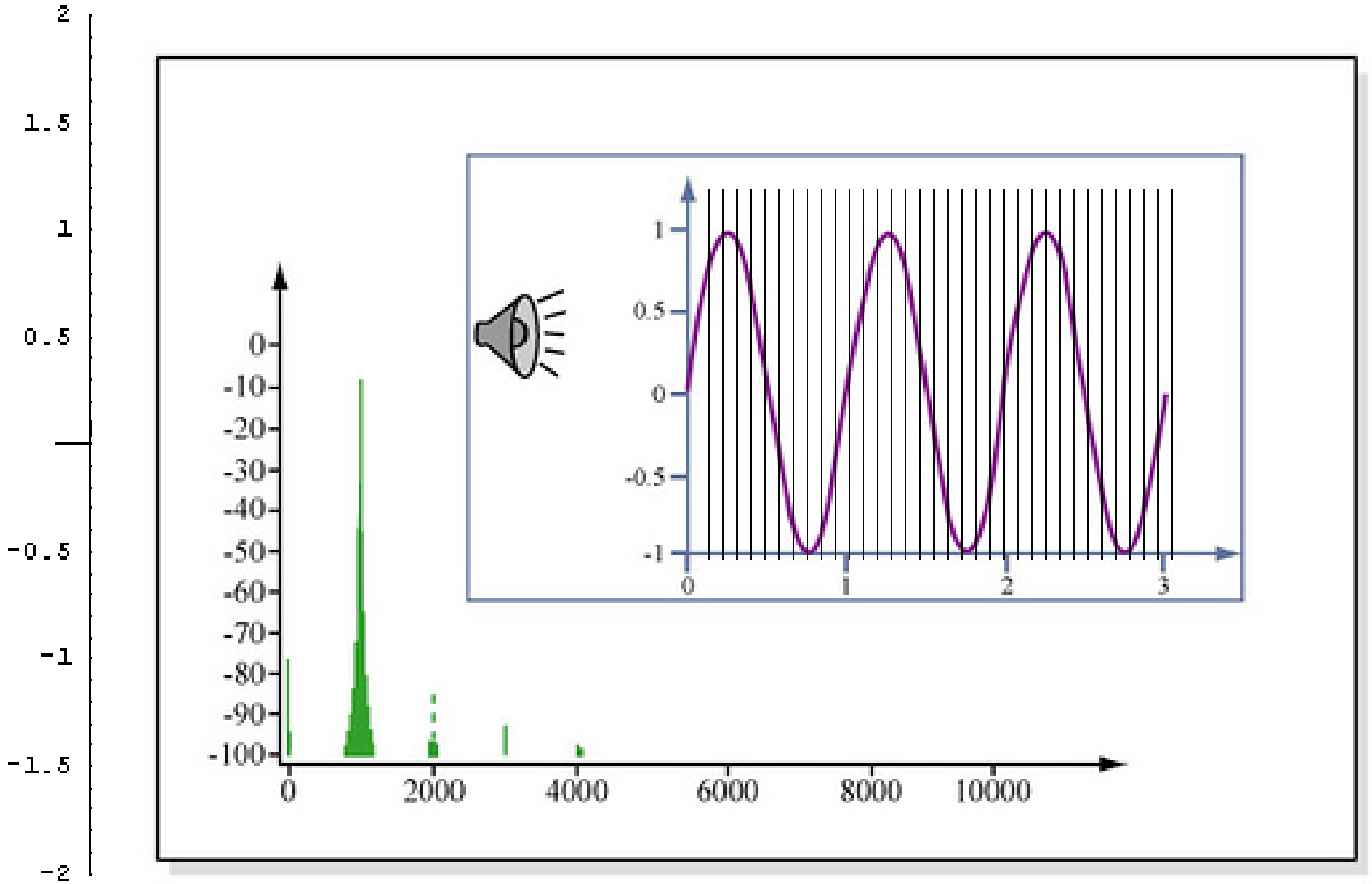
[3] Some intermediate carriers are signaling that the far end device has been offered the call therefore the originating carrier may not know the far end has not been offered the call

EXHIBIT B

Voice Quality – Why separate from Call Termination?

Fritz Hendricks

Conversion from Analog (Native Voice) to Digital (Both IP and TDM) is performed by a CODEC – more than TWO conversions in a call flow will result in poor quality



G.729
G.726
G.711
G.722
G.723

EXHIBIT B

Voice Quality – Why separate from Call Termination?

Fritz Hendricks

Conversion from Analog (Native Voice) to Digital (Both IP and TDM) is performed by a CODEC – more than TWO conversions in a call flow will result in poor quality

CODEC	Bit Rate/Kbps	Normal Ethernet Bandwidth/Kbps
G.711	64	90
G.729	8	32
G.723	16	22
G.726	32	54
G.722	64	90

Example Conversions:

1. Bluetooth in Car
2. Cellphone G.723
3. TDM
4. LD Carrier (Maybe VoIP)
5. Rural Termination (TDM/VoIP?)
6. Analog Line
7. Cordless Phone

All carriers operate as expected – call quality is still bad

Not rural carrier targeting

EXHIBIT B

PSTN is Constantly Changing

(panel discussion)

EXHIBIT B

Trouble-Shooting Call Complaints Requires Prompt Action by Multiple Parties

Matt Ottey

Trouble-shooting call complaints requires prompt action by multiple parties. Time is of the essence when isolating call completion issues

- Customers may wait to report issues, delaying ability to retrieve data needed to identify cause
- Customers must provide timely and accurate call detail to their service provider to start the process.
- SS7 or VoIP trace data is needed for troubleshooting issues.
- Each carrier's repair organization needs to quickly pull their own trace data to identify where they handed call off for termination.
- If necessary the next carrier down the line needs to be brought into the process quickly so that they can pull their call trace data before it ages off.
- Some carriers require call examples be less than 24 hrs. old to take a trouble. What if a problem is reported late? Over 24 hours?
- Lack of available subject matter experts

Matt Ottey

Trouble-shooting call complaints requires prompt action by multiple parties.

Many issues are intermittent (root cause disappears as circumstances change)

- Calls can take different routes.
- Issues on single routes/circuits can be difficult to identify without call traces.
- Intermittent hardware issues can cause problems to come and go.
  - Working path versus Protect path
  - Active unit versus standby unit.
- LCR Changes (QOS metrics, Time of Day, Financial updates) can change the problem dynamics.
- Proactive processes may clear a problem prior to isolation.
- Lack of proper signaling can make tracing the call difficult.

Matt Ottey

Trouble-shooting call complaints requires prompt action by multiple parties.

Involvement required from multiple carriers and end users to engage in test calls.

- Customer troubles that can't be duplicated or isolated with normal troubleshooting processes may require test calls with end users.
    - Coordinating all parties can be difficult.
        - Different time zones
        - Different work loads
        - Different schedules
        - Trouble handoffs between shifts/workers
        - Availability of customers
        - Availability of Subject Matter Experts & difficulty penetrating the company's front lines

Matt Ottey

Trouble-shooting call complaints requires prompt action by multiple parties.

Once problem appears resolved, resources are directed elsewhere, even if root cause is not identified.

- Troubleshooting resources often don't have time to dig for root cause of issues that came clear prior to isolation especially if call was handed off to another carrier.
- Test equipment placed in the network to troubleshoot issues gets moved to the next problem.
- Record retention is limited, access is limited by the troubleshooting parties (CPNI issues) or records are not kept with enough data.

Matt Ottey

Trouble-shooting call complaints requires prompt action by multiple parties.

- All carriers should agree to accept troubles up to 72 hrs. after the time of the call.

- Reported troubles from Rural LEC's must include:
  - Originating Telephone Number
  - Called Telephone Number
  - Date and Time of problem call (in GMT)
  - Description of the problem reported
    - Fast busy
    - Dead air
    - One way audio(which side couldn't hear)
    - Recording, etc.

- For all Rural LEC reported troubles/symptoms that can be duplicated, a specific root cause should be provided by the terminating carrier.

EXHIBIT B

Trouble-Shooting Call Complaints Requires Prompt Action by Multiple Parties

(panel discussion)

EXHIBIT B

Incentives for Financial Arbitrage

Lee VonGunten

Intercarrier Compensation and the Incentives for Financial Arbitrage

Financial Motives Associated with Rural Call Completion Issues

- NECA Rates are NECA Rates
  - The per minute NECA ICC rate is NOT the problem
- State Specific ICC Rates
  - Rural LECs in Many States Mirror NECA Rates
  - State ICC Rates are NOT the problem
- What is the Financial Incentive that is THE Problem
  - Simple Math: FCC Fines < Access Charges

Lee VonGunten

Intercarrier Compensation and the Incentives for Financial Arbitrage

- IF the primary cause of RCC issues is ICC access evasion, ***Who is at Fault?***
  - LEC or VoIP Provider from where calls originate
  - Least Cost Router that refuses to terminate the call
  - Carrier that hands off the call to a LCR
  - All of the above?

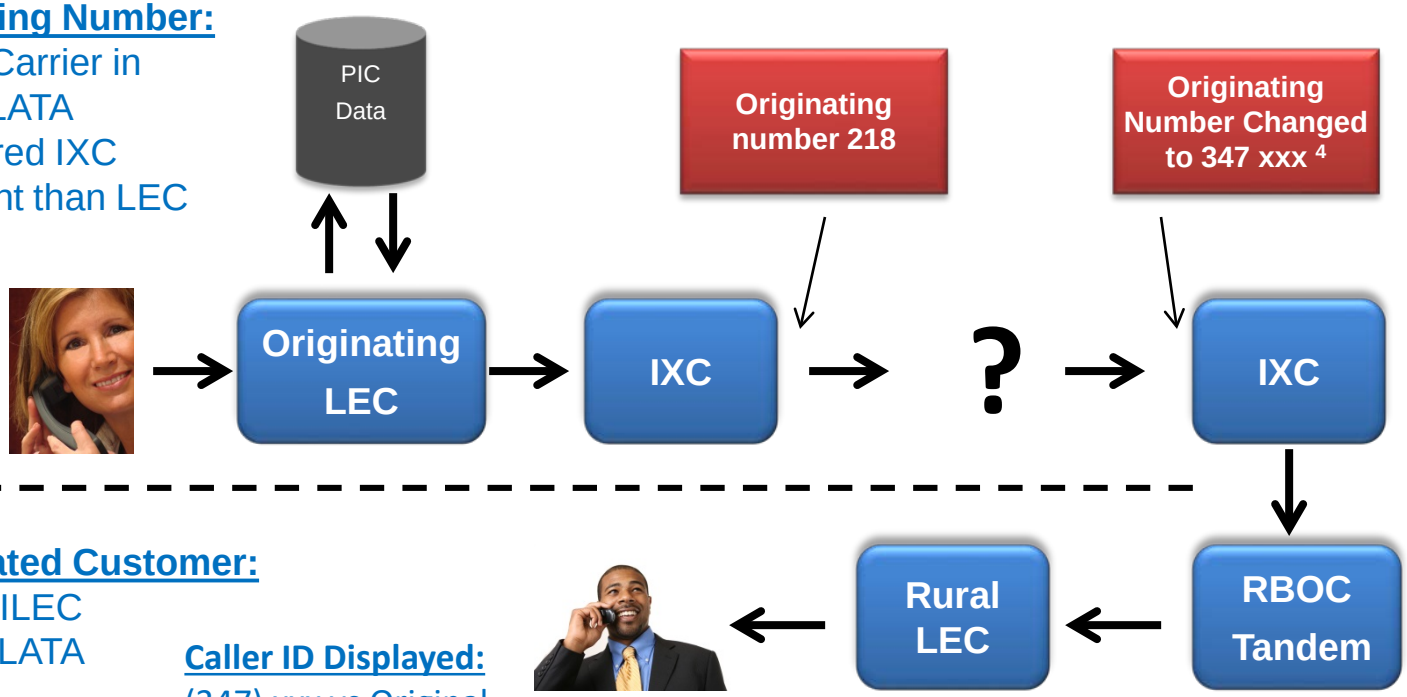
EXHIBIT B

Trouble Reported – Originating Number Change

Fritz Hendricks

Originating caller information is being changed in the middle of the call flow

Originating Number:
- Local Carrier in (218) LATA
- Preferred IXC different than LEC



Terminated Customer:
- Rural ILEC
- (218) LATA

Caller ID Displayed:
(347) xxx vs Original (218)

Rural ILEC has no regulatory authority to compel carriers in the call flow to disclose the call routing information required to isolate the carrier converting the call – this trouble is likely correlated to the failed call attempts issue

EXHIBIT B

Call Flow Example – Originating Number Change

Fritz Hendricks

SS7 & Tandem reports demonstrated that a large volume of calls per month were from the same 347 originating (changed from the 218 Originating number)

Sum of MOU	Column Labels										
Row Labels	January	February	March	April	May	June	July	August	September	October	Grand Total
347xxx4	16,639	21,680	24,806								63,126
347xxx3	12,209	18,434	26,870								57,514
347xxx6	13,278	25,609	19,905								58,791
347xxx4	15,884	22,025	29,269								67,178
347xxx9	50,686	47,054	69,839	22,586							190,164
347xxx4	17,797	19,498	30,691								67,985
347xxx7			20,676								20,676
347xxx8	37,522	40,542	60,306	19,474							157,844
347xxx9		15,493	25,644								41,137
347xxx7				8,703	8,516	21,088	11,045	10,951	11,450		71,753
347xxx5					9,069	21,779	11,150	8,146	10,322		60,465
646xxx6									2,980		2,980
646xxx0									19,658	5,827	25,485
760xxx8				38,182	63,377						101,559
801xxx5			2,188					2,159			4,347
801xxx0				206,810	20,641	19,336	43,357	94,054	130,595		514,792
Grand Total	**164,014**	**210,336**	**310,194**	**295,754**	**101,604**	**62,202**	**65,552**	**115,310**	**175,004**	**5,827**	**1,505,797**

Root cause = arbitrage of cellular and local/LD flat rate plans

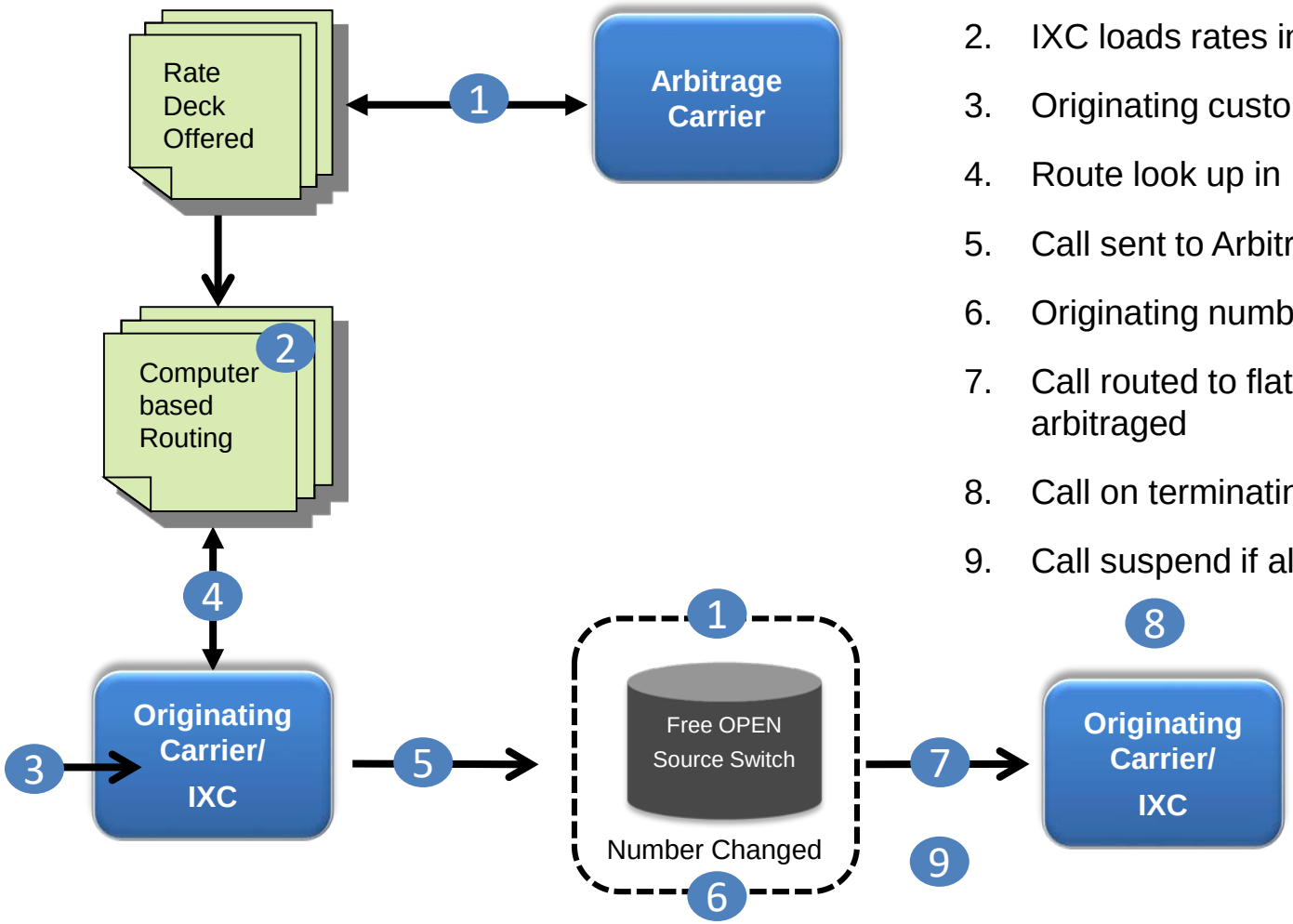
Arbitrage also caused call "suspension" problems!

EXHIBIT B

Originating call suspended in the Network

Fritz Hendricks

Arbitrage Carriers changes number or suspends call until channel available



1. Arbitrage can happen with a cheap computer, open source switch, and a rated deck
2. IXC loads rates into computer routing logic
3. Originating customer dial toll call
4. Route look up in IXC LCR system
5. Call sent to Arbitrage Carrier
6. Originating number change from 218 to 347
7. Call routed to flat rate or cell carrier being arbitraged
8. Call on terminating end displays 347 number
9. Call suspend if all channels full

Doug Davis

- **Pricing pressure** in toll-termination services is immense. Vendor rates vary and change often. Even the slightest change can, almost instantaneously, swing millions of minutes from one provider to another and an ever-moving flow of thousands of dollars results.

- **Least-Cost Routers** ("LCRs") are efficient tools that providers everywhere use to route calls based on each call's cost. HyperCube's study reveals that LCRs themselves do not necessarily contribute to call-completion and call-quality problems.

- **Multiple technical possibilities for entry** into rural networks: Sim boxes, VOIP gambits via Cable modems, OTT systems. Results in access calls being injected as local traffic into RLEC local network. Lack of policing may allow these schemes to flourish.

- **HyperCube's study** reveals some particularly-creative toll-termination vendors utilize non-conventional arrangements. The study also reveals that even the RLEC (or any other LEC or wireless carrier) whose network is being used to terminate toll traffic through non-conventional arrangements may not be aware of such arrangements without extraordinary and ongoing identification efforts.

EXHIBIT B

Doug Davis

Texas RLEC Case Study

Vendor Rate (average): $0.0044

RLEC Tariff Rate (access composite): $0.009

Low-Cost Vendor CCR at Busy Hour: 9% NER
Mid-Cost Vendor CCR at Busy Hour: 69% NER
High-Cost Vendor CCR at Busy Hour: 100% NER

CCR at Quiet Hour: 100% NER for all vendors

Conclusion: Sufficient facilities exist at or near the RLEC tandem; alternative (unconventional termination) routes existed and were in use.

Disposition: Contact with the RLEC resulted in the identification and closure of an IP vendor that had established a cable-modem system for call completion within the RLEC's network. Current vendor rates now align with the RLEC's tariff rates. Call completion is now meeting the P.01 quality objective.

EXHIBIT B

Doug Davis

North Dakota Tribal Reservation (RLEC) Case Study

Vendor Rate (average): $0.012

RLEC Tariff Rate (access composite): $0.015

Low-Cost Vendor CCR at Busy Hour: 11% NER
Mid-Cost Vendor CCR at Busy Hour: 95% NER
High-Cost Vendor CCR at Busy Hour: 100% NER

CCR at Quiet Hour: 100% NER for all vendors

Conclusion: Adequate facilities existed at or near the RLEC tandem; bad routing existed in the network.

Disposition: Contact with the RLEC resulted in the identification of an intermediate carrier whose LCR set-up was deficient with routing against another LEC's LRN. That other LEC was rejecting many calls due to capacity limitations. Once the intermediate carrier's LCR and routing were fixed, vendor rates aligned with the RLEC's tariff rates and call completion began meeting the P.01 quality objective.

EXHIBIT B

Doug Davis

Tier 1 Wireless Carrier Case Study– Rural Market

Vendor Rate (average): $0.0023

Tariff Rate (RLEC tandem, access composite): $0.0043

Low-Cost Vendor CCR at Busy Hour: 44% NER
Mid-Cost Vendor CCR at Busy Hour: 82% NER
High-Cost Vendor CCR at Busy Hour: 82% NER

CCR at Quiet Hour: 99% NER for all vendors

Conclusion: Sufficient facilities exist at or near the RLEC tandem; illicit Subscriber Identity Module ("SIM box") in use via alternative vendor.

Disposition: Contact with the wireless carrier unearthed the use of a SIM box having a capacity of over 200 channels and enabling an alternative vendor to provide termination services into the wireless carrier's network. The SIM box was removed, vendor rates aligned with the tariff rates associated with the regional RLEC tandem, and call completion began meeting the P.01 quality objective.

Doug Davis

- **ASR (Answer / Seizure ratio)**

  ASR is calculated by taking the number of successfully answered calls and dividing by the total number of calls attempted (seizures)..

- **NER = Network Efficiency Ratio**

  NER attempts to eliminate "User Behavior" from measuring network operations. NER is calculated as (Answers + User Busy + Ring No Answer + Terminal Rejects) / Total call attempts (seizures)

  Since busy signals and other rejections by the called number count as call failures, the calculated ASR value can vary depending on user behavior. Network operators tend to prefer to score keep using NER as a basic metric. While Call centers and other agent businesses prefer ASR as it measures the humans, too.

(Source in part:) Kennedy I., Lost Call Theory, Lecture Notes, ELEN5007 – Teletraffic Engineering, School of Electrical and Information Engineering, University of the Witwatersrand, 2005
Flood, J.E., Telecommunications Switching, Traffic and Networks, Chapter 4: Telecommunications Traffic, New York: Prentice-Hall, 1998.

Doug Davis

- **P.01 Grade of Service (*one lost call in 100)***
  - To calculate the Grade of Service of a specified group of circuits or routes, Agner Krarup Erlang used a set of assumptions that relied on the network losing calls when all circuits in a group were busy. Erlang was concerned about fixed wired systems where circuits were allocated in trunk groups and when you ran out of trunks, you ran out of the ability to send calls.
  - With VoIP and other technologies the concept of "trunks" "circuits" and "groups" has become less fixed and more virtualized, the original planning concepts and the grades of service desires have not changed. These metrics have just been "forgotten"
  - While the concept of fixed TDM trunking is "Old School" today ... Managing to the P.01 Grade of service from end to end would have eliminated the need to have this conference. Even though old Erlang B seems simple by todays standards, striving for such a simple standards as P.01 should put todays technology on par with yesterdays. At least as far as call completion goes.

(Source in part:) Kennedy I., Lost Call Theory, Lecture Notes, ELEN5007 – Teletraffic Engineering, School of Electrical and Information Engineering, University of the Witwatersrand, 2005
Flood, J.E., Telecommunications Switching, Traffic and Networks, Chapter 4: Telecommunications Traffic, New York: Prentice-Hall, 1998.

EXHIBIT B

Incentives for Financial Arbitrage

(panel discussion)

EXHIBIT B

Catastrophic Rural Failures Versus Normal Fluctuations in Call Completion And the Role of Unmanaged LCR

Penn Pfautz

Eyes on the Prize – Catastrophic Call Completion Failure

The driver for rural call completion initiatives was persistent unreachability, not minor variations in call completion

- Call completion is not engineered to be perfect and transient variations and occasional problems are expected, BUT
- Situations where customers are not reliably reachable by some parties are NOT acceptable
- Problems with least cost routing appear to be at the root of the catastrophic failures that should be the focus of industry efforts

EXHIBIT B

Penn Pfautz

Eyes on the Prize – Catastrophic Call Completion Failure

LCR can lead to failure through:

- Lack of engineered capacity – providers may lack the capacity to handle the traffic they take on
- Link proliferation and looping – when providers lack an available route they may hand off to others, who in turn hand off to further parties, etc.
  - This can result in issues with hop counter/Max FORWARDS or in looping back to a provider already in the route chain
- Lack of fallback – when routes congested provider may simply drop call rather than release back for originator to try another path
- False signaling – “Let’s not and say we did”
- Fraud and re-origination - e.g., SIM boxes
- Point is not that LCR is bad; just that it must be done right!
  - Carriers may have to rely on others for universal reach

Catastrophic Rural Failures Versus Normal Fluctuations in Call Completion And the Role of Unmanaged LCR

(panel discussion)

Technical Root Causes of Call Completion Issues

David Frankel / Matt Ottey

Technical Root Causes of Rural Call Completion Issues

Some commonality can be identified around technical root causes of call completion issues

- Hardware issues (bad card or switch module; trunks not properly connected; call processors)
- Software issues (soft-switch configurations; firmware; routing algorithms)
- Configuration issues (signaling issues; network translations; timing issues)
- Routing issues (looping; failure to route advance; complexity introduced by multiple carriers)
- No trouble found (non-repeatable issues)
- Unorthodox termination arrangements (use of local lines, etc., for access avoidance)

David Frankel / Matt Ottey

Technical Root Causes of Rural Call Completion Issues

Many issues are not unique to RURAL calls:

- Hardware failures; link failures; software defects – these happen everywhere

But the rural environment may make some failures catastrophic:

- Less redundancy means no path around failure
- Smaller pipes mean mass calling events can overwhelm available trunks
- More legacy equipment means higher chance of interworking issues
- Greater use of in-band signaling complicates debugging via metadata

Higher termination charges to rural areas drives greater use of LCR:

- “Third-tier” carriers more likely to be involved w/ less rigorous practices
- “Unusual” termination arrangements as discussed elsewhere

EXHIBIT B

Technical Root Causes of Call Completion Issues

(panel discussion)

Q & A

BREAK

Moderator

Panel 2

Discussion of Strategies and Best Practices to Prevent, Identify, and Resolve Rural Call Completion Issues

Chuck Griffin	Impact Telecom
Bob Gnapp	NECA
Jason Neumeier	Telephone Service Company
Matthew Ottey	Verizon
Jim Peelman	Comcast
Mary Retka	CenturyLink
Jennifer Torres	Level 3
Ron Grimes	Verizon ***Moderator***

Panel Discussions

Panel 2

Discussion of Strategies and Best Practices to Prevent, Identify, and Resolve Rural Call Completion Issues

- Process Excellence - Do it right or do it again
  Jason Neumeier

- Know your numbers; Metrics-driven approaches that hold promise
  Mary Retka / Jennifer Torres

- Fresh Complaints, Repeatable Problems; Robust Investigation Methodology
  Matt Ottey / Jim Peelman

- Two's company, three's a crowd
  Bob Gnapp

EXHIBIT B

Process Excellence -
Do It Right or Do It Again

Jason Neumeier

Process Excellence (Do it Right or Do it Again)

- Given billions of call events annually, even low levels of call completion failures related to process gaps or technical problems could overwhelm investigative resources and detract from efforts to identify and address catastrophic/systemic problems.
    - "Five nines" reliability for network equipment implies roughly 5 minutes of unplanned downtime annually for each of the tens of thousands of devices in the PSTN
    - P.01 grade of service implies blocking of potentially up to 1% of calls during peak busy hour
    - A 99% call completion rate implies over 350 million calls annually that don't complete
- Carriers need to implement quality processes to ensure basic functions of network maintenance, modernization, and repair don't introduce failures into the network.

Jason Neumeier

Process Excellence (Do it Right or Do it Again)

- Carriers should have written procedures for all activity that touches the network.
- Devices, software and configurations should be validated in lab environments before being introduced into production.
- Implementation procedures should be documented and should include verified back-out procedures to ensure ability to revert to last known good operating environment in the event things don't go as planned.
- Network alarming should be in place to promptly alert carriers to service-affecting events.
- Network metrics should be monitored to ensure performance within intended operating parameters.

EXHIBIT B

Process Excellence -
Do It Right or Do It Again
(panel discussion)

Know Your Numbers; Metrics-driven Approaches That Hold Promise

Mary Retka

Know Your Numbers; Metrics-driven Approaches That Hold Promise

Testing for Call Completion

- Ongoing testing using:
    - Call Detail Records (CDRs), routing tables, and daily traffic information
    - Automated algorithms, and internal analysis tools
    - Apply specific system coding, designed for selecting components of call paths where network performance could be impacted due to network traffic, and which may have effects on NER, and ASR
- Determine OCNs and routes which could have cause for investigation.

Mary Retka

Know Your Numbers; Metrics-driven Approaches That Hold Promise
(Continued)

- Filter trouble tickets into the provider's normal trouble ticketing system for normal trouble ticket processes to be applied against.

- Technicians then have the CDR details, routing information, timing of the issues and information to trouble shoot and test, in order to determine the cause of the issue.

- Over a month's period of time several OCNs will be tested.

- This approach to daily, routine, automated analysis, and testing provides a reliable and controlled process, and delivers targeted, statistically correct, fixed testing, using established processes, in a near real time approach, to address the network performance.

Jennifer Torres

Know Your Numbers; Metrics-driven Approaches That Hold Promise

Vendor Performance Management - Consistent monitoring of over all vendor performance

- How is the vendor performing overall?
  - Trouble Ticket per Million MOU
  - At vendor level
  - At OCN level

- How do you expect your vendors to perform?
  - Define what is acceptable
  - Vendor Scorecards

- Hold vendor accountable for their performance
  - Status calls of their performance
  - Read out on where they're under performing
  - Set expectations on improvements
  - Footprint limitations - If problems persist take vendors out of route

Jennifer Torres

Know Your Numbers; Metrics-driven Approaches That Hold Promise

Vendor Performance Management

- Opening Trouble Tickets
  - Should a third party network impact a customer on your network, ensure there are trouble tickets opened with that third party to resolve the issue
  - Set route exceptions while the NOC teams from both groups resolve the issue
  - Keep third party contact and escalation information readily available

EXHIBIT B

Know Your Numbers; Metrics-driven Approaches That Hold Promise

(panel discussion)

EXHIBIT B

Fresh Complaints, Repeatable Problems; Robust Investigation Methodology

Jim Peelman / Matt Ottey

Fresh Complaints, Repeatable Problems; Robust Investigation Methodology

Rural Identification and Ticket Handling Process

- Reactive Measures
  - Customer inquiries to 1-800-COMCAST result in the creation of trouble tickets that formally track progress and resolution of call completion and call quality related issues. Tickets are routed to a specific team within National Voice Services.
  - The National Voice team works with the Intermediate Carrier to determine if the issue can be immediately resolved. If not, the issue is escalated to a higher tiered support team for correlation and coordination if a re-route of traffic is warranted.
  - If route is tested successfully, routing is reverted to the original intermediate carrier; if no progress is made within 20 days, reroute is frozen and made permanent to ensure the customer experience.
  - Carriers can directly engage Comcast's National Voice team via a dedicated email address and a Carrier-to-Carrier support line.

Jim Peelman / Matt Ottey

Fresh Complaints, Repeatable Problems; Robust Investigation Methodology

Rural Identification and Ticket Handling Process

- Proactive Measures
  - National Voice Team is engaged in continuous dialogue with both the engineering teams as well as Operations Compliance working to refine our Ops processes in an effort to improve the overall model.
  - Intermediate carrier performance is continuously monitored and chronic behavioral patterns that present potential customer risk are noted and trouble tickets are opened with intermediate carriers in an effort to mitigate issues.
  - Once an issue is noted and action taken, the National Voice team will work with the intermediate carrier(s) in the same fashion as a customer initiated trouble ticket.
- **Panel Discussion**
  - Discussion on feedback to process, consensus on working through repeatable intermediate carrier challenges, and areas of improvement.

EXHIBIT B

Fresh Complaints, Repeatable Problems; Robust Investigation Methodology

(panel discussion)

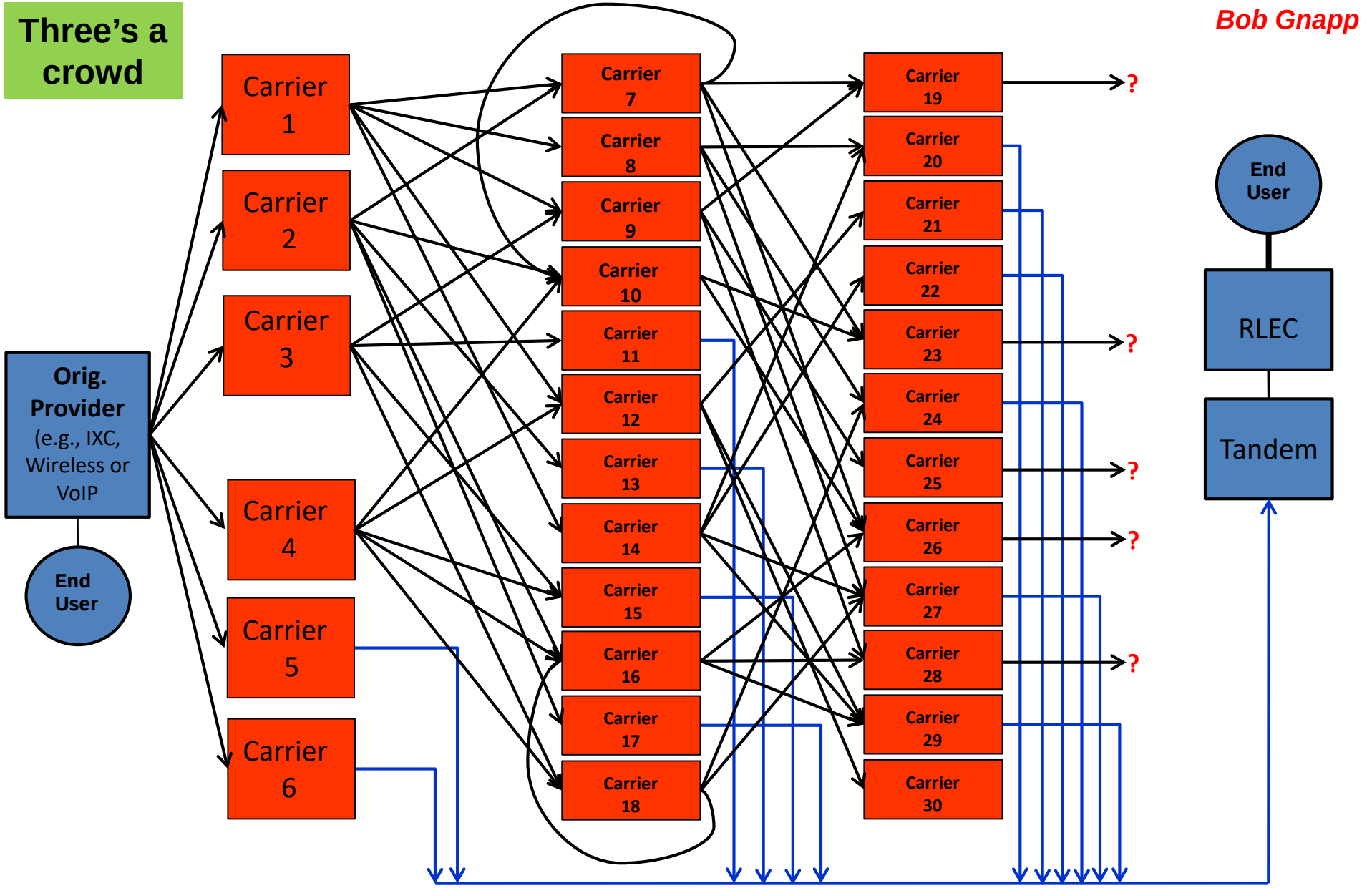
Two's Company; Three's A Crowd

EXHIBIT B

Panel 2 – Topic Overview

Three's a crowd

Bob Gnapp



Panel 2 – Topic Overview

Two's company

Bob Gnapp

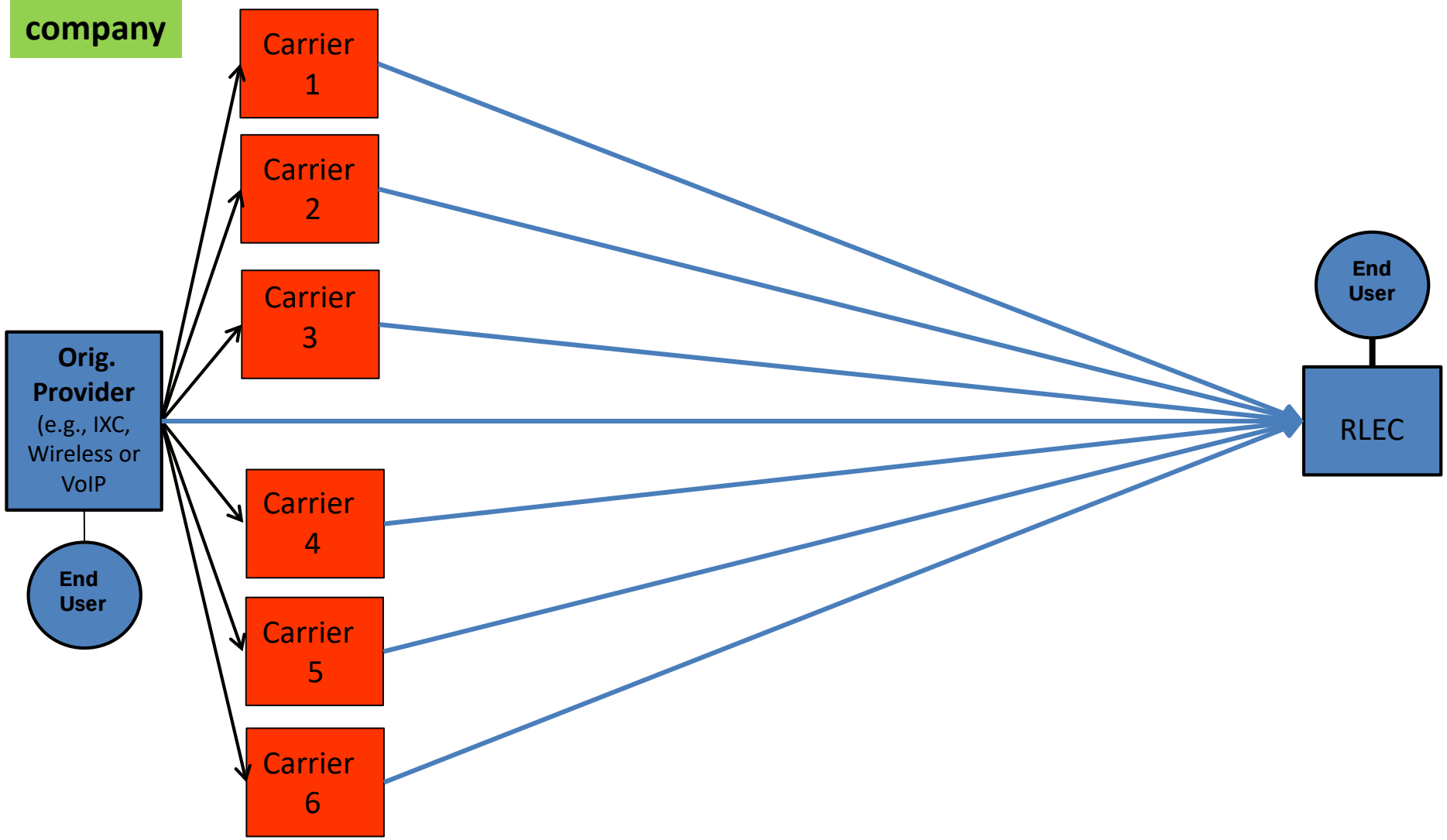


EXHIBIT B

Panel 2 – Topic Overview

Two's company

Bob Gnapp

Bob Gnapp

Lifting the veil

- Require call termination provider registration /certification
  - FCC Order and FNPRM, Senate Bills S.2125 and S.827
- Call termination provider report cards/performance indexing?
  - NDA issues?

Two's Company; Three's A Crowd

(panel discussion)

Moderator

Post-Workshop Action Items: Next Steps

- ATIS (www.atis.org) Next Generation Interconnection Interoperability Forum (NGIIF) has published an Intercarrier Call Completion/Call Termination Handbook.
  https://www.atis.org/docstore/product.aspx?id=26780

- NGIIF Co-Chairs: Amy Hindman (Verizon) and Mary Retka (CenturyLink)

- Following this Workshop, Verizon will be making a written submission to NGIIF recommending updates to the NGIIF Call Termination Handbook intended to help document the ideas, best-practices, and recommendations discussed at this Workshop.

- All others are invited to reach out to NGIIF to obtain information on how they, too, can participate in the process of updating the Call Termination Handbook.

Moderator

Post-Workshop Action Items: Academic Research

- Verizon is sponsoring academic research on methods to detect and resolve rural call completion problems in real time.
- The minimum amount of funding for the sponsored research is $30,000 and the maximum amount of funding that could potentially be awarded is $50,000.
- Proposals will be accepted until midnight Eastern Daylight Time on Thursday, July 2, 2015. Research is required to be completed by December 31, 2016.
- Further information and a copy of the Request for Proposals is available from rcc-proposals@one.verizon.com

Q & A

EXHIBIT C

EXHIBIT C

GEORGETOWN UNIVERSITY

SECURITY AND SOFTWARE ENGINEERING RESEARCH CENTER

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

April 18, 2017

Dear Ms. Dortch,

The Security and Software Engineering Research Center (S^2ERC) is a National Science Foundation-sponsored, industry-supported[1] research center with the mission of connecting people and bringing the world closer together through new technologies, policy, law, and economics around communication technology. The goal of our research is to enable security and software technology gains within member organizations and to protect the security and stability of our public networks.

With funding from S^2ERC affiliates, most notably Verizon, the S^2ERC embarked on a project to examine rural call completion issues. The attached paper is a technical report describing our findings, results, and our experience with a new metric we developed which we call Human Retries (HMR). We presented this paper at the Industry Workshop hosted by Verizon on March 29, 2017.

We welcome any questions or comments on our work. I can be reached by phone at 202-687-4107 or by e-mail at eric.burger@georgetown.edu.

Sincerely,

Dr. Eric Burger
Research Professor of Computer Science
Director, S^2ERC at Georgetown University

[1] The NSF supports the work of the S2ERC through grant IIP-1362046. The NSF defines 'industry' as any funding source, public or private, that is not the NSF.

GEORGETOWN UNIVERSITY

S^{2}ERC Project:	Rural Call Completion
Report:	Issues, Analysis, and Tools For Rural Call Completion Issues
Author:	Trent Stohrer, Research Staff
	Andrew Stewart, M.S. Student
	Dr. Eric Burger, Research Professor of Computer Science
Status:	For Publication
Date:	March 27, 2017

Abstract

Changes to the wireline telephone network, including the introduction of new technologies such as SIP and the gradual reduction of wireline subscribers, has led to a network environment with higher reports of issues connecting calls to rural areas than there were ten years ago. Old network performance metrics seem incapable of identifying these previously unseen or unreported problems. The Federal Communications Commission (FCC) cites three factors: uncaptured or incorrect signaling, the presence of automated call traffic, and the increase of phone numbers without subscribers, which work together to reduce the capability of older metrics to measure network health. Using data from wireline providers and our knowledge of the symptoms of the connection problems, we created a new metric, called HMR, intended to be as independent from these factors as possible, with the intent being to deploy it to identify and resolve problems with calls to rural areas on a day-to-day basis or more frequently. While we were unable to completely disentangle HMR from some issues that cause problems for the old metrics, we were able to detect anomalies that potentially indicate problems that the other metrics were not able to capture. More work needs to be done to further reduce the influence of the complicating factors and to determine whether the data anomalies represent actual problems in the network.

This material is based upon work supported by the National Science Foundation under Grant No. 1362046 and the industry affiliates of the Security and Software Engineering Research Center (S^{2}ERC). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or the S^{2}ERC affiliates. Payments are made to Georgetown University and the funds are used to cover the expenses of the study and related academic and research activities of the institution.

Introduction

Rural Call Completion is a blanket term for a series of problems that have been reported to the FCC by several states as well as trade associations that represent rural carriers carriers (collectively "rural associations"). As the name suggests, these Rural Call Completion problems (RCC from here forward) involve issues with completing calls that exist specifically with calls to the rural areas of the PSTN (Public Switched Telephone Network).[1][2] RCC is not one specific technical problem but rather a series of symptoms which, according to reports of incidents at the FCC, include the following: "lengthy periods of dead air on the calling party's end after dialing a number, audible ringing tones on the calling party's end when the called party's telephone never rings at all, false busy signals, inaccurate intercept messages, the inability of one or both parties to hear the other when the call does go through, and calls simply not arriving at their destinations." The FCC has stated that, "the inability to complete calls reliably threatens public safety and contravenes the public interest." For example, the FCC reported "examples of life-threatening call failures, including a situation where an on-call surgeon was unable to receive a call from a hospital for emergency surgery and a 911 call center was unable to do emergency call backs."[3]

According to the FCC, "there appear to be multiple factors that may cause rural call completion problems. Rural associations posit that the call completion problems may arise from the manner in which originating providers set up the signaling and routing of their calls, and that many of these call routing and termination problems can be attributed to intermediate providers." Least cost routing carriers (also known as LCRs) offer terminating services at low rates, and the rural associations argue that some LCRs who provide such intermediate transport may provide inferior service to achieve their lower rates. The FCC offers LCRs could be a cause of RCC problems due to high access charges for calls to rural areas which provides an incentive to use cheaper LCRs. Another factor cited is there are fewer potential routes to terminate to each rural location, thus meaning that for universal connectivity it is difficult to impossible for any single carrier to connect to each and every rural carrier. According to an industry speaker from the First RCC Industry Workshop,[4] some of the LCRs they investigated are able to function during times of low call volume. However, during peak traffic, when their circuits are full, they begin to handle calls incorrectly. This can manifest as the LCRs holding onto calls without handing them back for re-routing, playing a ring or other treatment before any connection has been established, or simply returning a release code and releasing the call rather than attempting to complete the call.

The FCC has stated that "one key reason for the increased problems in rural areas is that a call to a rural area is often handled by numerous different providers in the call's path. Given the particularly high rates long-distance providers incur to terminate long-distance calls to rural rate-of-return carriers, long-distance providers have additional incentives to reduce the per-minute cost of calls. For example, the disparity between interstate rates can be 5-6 cents per minute for rate-of-return areas and just over half a cent per minute for price cap areas.[5] As a result, there is greater incentive for the long-distance provider to hand off the call to an intermediate provider that is offering to deliver it cheaply – and potentially less incentive to ensure that calls to rural areas are actually completed properly." This problem is potentially exacerbated by the industry's move towards Voice over Internet Protocol (VoIP) and the ease with which a party can set up a server capable of handling and routing Internet-based calls. In the First Industry Workshop, it was

[1] Federal Communications Commission, *Report and order and further notice of proposed rulemaking in the matter of rural call completion*. 2013, pp. 1–2, WC Docket no. 13-39.

[2] By "rural carrier," we mean an incumbent high-cost, rate-of-return carrier, as defined by the FCC. The FCC defines a rural carrier as those designated as such by the National Exchange Carrier Association (NECA). *See Report and Order*, ¶9.

[3] Federal Communications Commission, *Report and order and further notice of proposed rulemaking in the matter of rural call completion*. 2013, p. 8, WC Docket no. 13-39.

[4] Verizon Public Policy, *2015 rural call completion industry workshop: Panel 1*, 2015. [Online]. Available: https://www.youtube.com/watch?v=quQnIlAm3Qc (visited on 03/10/2017).

[5] Federal Communications Commission, 2017. [Online]. Available: https://www.fcc.gov/general/intercarrier-compensation-0 (visited on 03/10/2017).

mentioned that in an investigation into an RCC problem one of the panelists' companies found a LCR that had purchased a SIM box and was acting as an alternate vendor for terminating calls.[6] In other words, with some relatively cheap hardware, free software, and a flat-rate plan these actors were able to insert themselves into the PSTN. We have also heard of a user on a flat rate plan routing calls through his plan and acting as a "least cost router."

The FCC has taken on a number of regulatory actions in order to alleviate RCC issues. This has included agreements with companies to report levels of monthly answer rates, measured by answer-seizure ratio (also known as ASR), and perform investigations into rural carriers[7] with unexpectedly low monthly answer rates. A number of companies have entered into Consent Decrees with the FCC whereby the companies have taken a number of steps intended to ameliorate RCC issues. These steps include investigations into Rural OCNs[8] with negative spikes of ASR[9] or if they have any other reason to believe they are having RCC issues. The Bureau has also worked on expanding the adoption of safe harbor rules whereby an Inter-Exchange Carrier (IXC) agrees to either deliver calls directly to rural carriers or only hand the call off to carriers that will directly deliver the call to the rural carrier. Essentially, the IXC agrees to use at most one LCR in the path of the call, which makes untangling any issues that do arise in the network much easier. As part of a consent decree, this study was commissioned to review current methods for detecting and resolving RCC problems, improving metrics and data collection, and to develop new tools to improve the RCC situation.[10]

Today's problem detection is either ad hoc, when a caller complains, or post hoc, from running batch reports on call detail records (CDRs). Neither method is substantially real time. This has drawn us to a line of research where we investigate whether the data is available, in the real-time signaling path, to collect meaningful metrics on call failures. The current reporting statistics for RCC involve looking at network data over a period of time, usually a month, to try to identify anomalies in call completion or network performance, and then to take responsive action. Given the importance of these issues, there is a desire to try to remediate issues in as near-real time as possible. In our research, we have determined that the current ratio-based metrics are inadequate for uncovering RCC-specific problems, and as such we have worked to develop a new metric, which we refer to as Human Retries, or HMR, to help detect the various RCC symptoms relayed above. The metric can be deployed in a variety of ways and is not reliant on long time frames of data, such as a month, but rather can be used on a day-after basis, or perhaps faster, depending on how quickly a carrier generates call records. We evaluated the feasibility of calculating and analyzing HMR as call detail records are added to the database and have also attempted, with limited success, to calculate HMR in real time.

1 Description and Shortcomings of ASR and NER

Two of the more well-known measures of a network's ability to deliver calls are Answer-Seizure Ratio (ASR) and Network Effectiveness Ratio (NER). ASR is a metric developed by industry and mandated by the FCC for reporting. Carriers report on a month-to-month basis to the FCC. As its name suggests, ASR is the ratio of answered calls to total line seizures. In practice this can be calculated as answered calls with normal call clearing over all calls not receiving SS7 release cause

[6] See video in note 4, all other references to the industry workshop refer to this video.

[7] An ILEC is an "Incumbent Local Exchange Carrier." In this paper, we refer to high-cost carriers as "rural carriers." For the most part, high cost, rate-of-return carriers are rural carriers, even though a high cost carrier may not be in a rural region and a carrier in a rural region may not be a high cost carrier.

[8] OCN is an acronym for an Operating Company Number, used to designate different telephone companies.

[9] A negative spike is a sharp decrease from prior measurements over a short time. The exact parameters of what is a "sharp decline" varies. The important aspect is the sudden short-lived aspect of the change.

[10] Federal Communications Commission, *Order in the matter of Verizon*. 2015, 18(b)[2], DA 15-74.

code[11] 1 for unallocated and unassigned numbers.[12] Some methods for determining ASR include all calls in the denominator, including the call attempts receiving code 1, but we will get into why that is a bad idea in a bit. NER is a related metric to ASR. NER is also a ratio and has the same denominator as ASR, excluding calls receiving code 1, but it counts some calls as successes that ASR does not. The general idea behind NER is to not count the behavior of the terminating users against the network. For example, under ASR a call with a busy signal is considered a failure but in NER it is considered a success; the network performed as expected and only received a busy signal because the end user was already on the phone. The exact implementation of NER can differ slightly depending on what behavior you're trying to capture. The most forgiving of these methods is to count all calls receiving code 16, 17, 18, or 31 as successes. In our method, the numerator for NER includes calls that receive release codes for user busy (code 17) and no user responding (code 18) in addition to the answered calls with normal clearing counted in ASR. If signaling were completely reliable in all cases NER would also count as successes calls which are connected but not ever answered, perhaps because the end user is not home. This is also known as a "ring no answer." unfortunately, as we shall see in a bit, in practice counting ring no answers as successes is not reliable, as they are often indistinguishable from other types of call failure. In theory, we could count every call receiving code 16 (normal call clearing) as a success, and some carriers do this, but in practice this method ignores and obscures certain facts about signaling in the current networking environment.

ASR and NER are fundamentally similar metrics in that they are ratios of calls considered successes over all calls (ASR), or all calls that have a chance to succeed (NER). In our research, the difference between the two is in many cases negligible, especially when excluding the code 1 calls from the denominator. We will elaborate on this shortly. First, though, we will describe the data set and approach we used to analyze the RCC situation and to create RCC tools.

2 Call Data and Approach

The major goal of this project was to review current metrics, methods, and data for detecting RCC and other network problems in order to develop real-time tools for detecting and resolving RCC problems. Our aim was to create metrics and tools that could at worst be deployed on a day after basis, as that would be a massive improvement over using monthly metrics to trigger investigations, with the ideal being more real-time, on the order of five to fifteen minutes. In order to help us review existing metrics and to create new ones, Verizon provided us with one month's rural call data.[13] Subsequently, Verizon responded to our request for more records with over five months-worth of additional data. We also received call data from inContact as part of their consent decree.[14] Level 3 provided rural call data at the request of FCC staff to assist in evaluating the tools for general applicability.[15] Both inContact and Level 3 provided us with two months of call data.[16]

Of the 50 Terminating OCNs[17] in our main dataset with the lowest ASR (where the code 1 calls are included), 23 of them also rank in the 100 worst OCNs in terms of NER. Not surprisingly,

[11] ITU-T, "Digital subscriber signalling system no. 1 and the signalling system no. 7 isdn user part," International Telecommunications Union Telecommunications Sector, Tech. Rep. Q.850, May 1998.

[12] We will be discussing many release codes in this paper. A release code is a standardized code that explains why a line was released. In the example above, we include all release codes except for code 1, 16, and 17, representing unassigned number, normal call clearing, and user busy respectively, all being the most prominent. *See Q.850* for more details.

[13] We will refer to this as the main or primary dataset.

[14] Federal Communications Commission, *Order in the matter of inContact, Inc.* 2016, 19(b), DA 16-466.

[15] The first month of data from Level 3 is what we refer to as our secondary dataset.

[16] All three carriers entered into strict non-disclosure agreements with Georgetown; there was no intermingling of the data; the machines were not connected to the Internet; the data was striped and stored on encrypted partitions; and only the three Georgetown researchers had access to the data.

[17] OCN is not the most granular measure and in some instances a carrier will use different routes to get to different End Offices (where customers' lines physically connect) within that OCN. That said, the FCC asks for reports on an OCN-by-OCN basis and in our main dataset there are a more manageable 1216 OCNs compared to 7959 End Offices.

the 21 remaining OCNs that are outside of the 200 worst in NER have 34% or more of their calls receiving code 1 and many of them have over 50% of their calls receiving code 1.[18] Therefore, when we calculate both ASR and NER we exclude calls receiving code 1 from our calculations as these calls introduce a tremendous amount of statistical noise and make network performance appear much worse than it is. The preponderance of code 1 calls arises from the current network environment and the large presence of robo-callers and other auto-dialers. There are cases of 'smart' auto-dialers that only call numbers believed to belong to people or businesses. However, many automated systems just call a block of numbers in sequence, indiscriminately. There is no incentive for an LCR to send a false code 1, as these calls do not play into inter-carrier compensation. So, we can be relatively certain that if a call receives a code 1 that it is to a disconnected number and thus never had a chance of being successful. On the other hand, when humans place calls they tend to call people and businesses. Except in the relatively rare cases of a mis-dialed, changed, or a recently disconnected line, calls to people from people do not typically receive code 1. As such, a large percent of calls receiving code 1 tells us much more about the profile of those placing calls to a particular area and the allocation of the numbers in that area,[19] than it does about a network's ability to deliver calls there.

With the code 1 calls removed, the correlation between ASR and NER is made even clearer. Of the 50 OCNs with the lowest ASRs (code 1's removed from denominator) in our main dataset, all but six, or 44 out of 50, are also among the 50 worst in NER. Of the remaining six, three have NERs that would rank in the 100 worse and the other three all have similar reasons for having a low ASR but a high NER. Specifically, all three OCNs are in the top five for calls receiving busy signals, having 22-32% of their calls receiving busy signals (the average is 3.7%). Beyond that, for these three OCNs the busy signals are mostly caused by calls from a single originating number in two cases[20] and to a single terminating number in the third case.[21] The metrics are even closer when we look at the worst performing OCNs in terms of NER. Of the 50 OCNs with the worst NER, 43 of 50 are also among the 50 worst in ASR, but all 50 are among the 75 worst in ASR. These examples are not to say one metric is better than the other or to say that they are exactly equivalent. Rather, they both perform similarly when it comes to identifying where, or if we were to slice up the data differently, when, the network is performing abnormally or especially poorly. However, as the dive into the low ASRs that do not have correspondingly low NERs suggests, these metrics can be skewed rather easily by single numbers on either side of the call path (origination or termination), meaning NER and ASR seem to be better at catching acute problems with call delivery rather than chronic problems.

Since ASR and NER are calculated in similar ways, the two have similar shortcomings. Due to current factors in the PSTN, such as the large presence of robo-callers and disconnected numbers, these metrics have limited utility. Both metrics can easily be calculated and analyzed on various slices of the data: month-by-month, day-by-day, hour-by-hour, OCN-by-OCN, end office-by-end office, by intermediate carrier (or LCR), etc. No matter how we have sliced the data, though, the problems that exaggerate how bad certain slices are continue to exist because they are, as far as we can tell, inherent to the network. This is not to say that NER and ASR are not useful, in fact they both perform quite well in finding times and places where an outsize number of call failures are happening. Rather, the network characteristics we keep referring to, which can compound together and be difficult to control for, skew both metrics to varying degrees.

The prime network factors that tend to skew ratio-based metrics are somewhat similar and, in terms of results, closely related: robo-callers/auto-dialers and disconnected numbers. Robo-callers (we will use this term to refer to both robo-callers and auto-dialers[22] from here on) drive an enormous

[18] The average of release code 1's for OCNs in the main dataset is 6%.

[19] The percent of numbers that are allocated differs from end office to end office and can be quite low. To be more specific, offices are given numbers in blocks of 1000 numbers. A typical rural carrier has 2400 customers. Since they will have at least three blocks of 1000 numbers (3000 in total), quite a few will not be assigned. In this example, 20%

[20] 84% and 60% of calls receiving busy signals from a single number in the cited case.

[21] 93% of the calls receiving busy signals are to a single number in the cited case.

[22] The two are similar in that they place lots of calls to lots of different numbers and do so with varying levels of

percentage of the traffic. Because their call patterns are so different from typical customers, their calls can wreak havoc on ratio-based metrics. Identifying which callers are robo-callers is currently an unsolved problem, but using a method recommended to us by one of our industry contacts,[23] we can demonstrate the sort of impact that robo-callers have on the current environment. Our main dataset has 20.3 million unique originating callers, of which only 3,449 numbers, or 0.17%, meet our somewhat simplistic criteria for robo-caller. However, those 0.17% of originating numbers account for 42% of the calls in the set. If robo-callers behaved more like human callers this would not necessarily be a problem, but unfortunately, they differ from humans in that they call disconnected numbers more frequently than humans do.[24] Additionally, with the widespread adoption of features like caller ID, even when robo-callers do call a human rather than a disconnected number, there is a higher than normal chance the receiving party will simply not pick up, because they do not recognize the number. This means calls by robo-callers have a lower chance of being answered even when the called party is human, meaning they have a higher probability of being counted as failed calls in both ASR and NER.

The other major complicating factor for the ratio-based metrics is the presence, and, in fact, preponderance of disconnected numbers. As with robo-callers, the presence of disconnected numbers is not necessarily a problem in itself, but rather the current network conditions cause various issues that result in disconnected numbers obscuring our metrics. Research with industry suggests there are both OCNs and LCRs that cause calls to disconnected numbers to receive a release code other than 1. In some cases, this may be due to misconfigured or outdated hardware returning the wrong code,[25] and in other cases caller hang-ups can cause a failure to capture the release code, defaulting the call to a non-answered, normally cleared call (code 16), which will count as a call failure in both ASR and the more conservative version of NER we described above.[26] It should be noted that from the vantage of the originating carrier, we do not believe it is possible to tell where signaling issues originate, just that they exist. Our investigations into calls to specific OCNs suggest that there are in fact problems with communicating the correct code, though our limited network view makes it impossible to determine why these problems exist and where in the call path they occur. The simplest, and crudest, way to show this impact is the overall effect of removing all terminating numbers with zero answered calls in the dataset from our metrics.[27] This one adjustment moves the overall NER of the dataset from 63.3% to 81.4%. On a more granular level, there is plenty of evidence that problems with signaling for disconnected numbers exists. In our main dataset, 11% of the OCNs have no calls receiving code 1's and 30.4% have fewer than 10 calls in the set receiving code 1, with none of those accounting for more than .4% of the calls for that OCN in the set. Many of these OCNs with very low percentages of calls getting code 1 have inflated percentages of calls receiving codes that are similar to code 1, but with subtly different meanings.[28] On the other extreme end, 10% of the OCNs in the dataset have over 95% of their calls receiving code 16 for normal call clearing. It is possible that these percentages are simply a reflection of the nature of the calls to these OCNs, since if only calls by humans are made to an OCN and those people rarely misdial it would be reasonable for very few calls to receive code 1. However, given the dropping number of landline subscribers and

discrimination, though from what we understand both types of parties are not usually very selective in who they call.

[23] This method considers any originating number that places over 1400 calls/day during the course of a month to be a robo-caller.

[24] 44.8% of the calls placed by the numbers identified above receive code 1, compared to 18% of the calls placed by all other numbers receiving code 1.

[25] Such as code 3 or 34 instead of code 1, both of which will count against the denominator, and thus the 'score' of both of the ratio based metrics.

[26] To be more exact, what happens is that the release signal from the party hanging up (which will be code 16) reaches the carrier before the signal with the code indicating that the call is to a disconnected number. This is the network working as intended, but providing data that makes the call look like a failure.

[27] This is an illustrative exercise we performed, but we did not use it for analysis. We believe something like this may be useful for getting some noise out of the data but our sample is too small to definitively start ruling numbers with a single unanswered call as "disconnected numbers." This would, we believe, cast far too wide a net and miss calls to active numbers that just happen to not answer in the few calls we have for them.

[28] Most commonly we have seen inflated percentages for code 3 (no route to destination) and code 31 (normal, unspecified) in our main dataset and code 63 (Service or option not available, unspecified) in our secondary dataset.

the continued existence of robo-callers, we believe that this unlikely scenario cannot be the case for such a large number of OCNs and that there is sufficient evidence in the data that we should expect a codes other than 1 for some calls to disconnected numbers, which will inevitably result in such calls being labeled as failures by existing metrics.

As discussed above, incorrect signaling for disconnected numbers, and in some cases *correct* signaling, will result in the network appearing to perform worse than it is performing in reality, as calls that should not be counted towards the ratios are counted as failures. Unfortunately, ambiguous signaling also brings about another phenomenon in the data that further reduces the effectiveness of the ratio-based metrics. This phenomenon results in an originating number attempting to call the same terminating number over and over again, in many cases once per second for a minute or more. We refer to this phenomena as "machine retries"[29] or "call bursts." In one particularly extreme example from our main dataset, there are 428 records of one number calling another over about six and a half minutes, all but two of which received a code 3. According to the company who provided these records, they try at most six paths before handing a call back to the previous carrier, and even then almost all calls try only one path. It is likely that either some carrier further back in the call path or the originator of the call itself, in the case of hardware designed to retry when given certain release codes, simply retried different paths for the call or the call itself over and over and over. Though a rigorous analysis of the composition of the codes that come with this phenomenon has not been done, it should be noted that nearly every investigation of OCNs with outsize percentages of abnormal release codes has come with machine retries present to differing degrees.[30] Now, these retries could possibly put some stress on the network, and we have seen cases where that is almost certainly the case, but they also act to heavily skew the ratio-based metrics. Let's take those 428 calls to one number as a simple example. The end office[31] for that terminating number had 928 total calls for the day when that burst occurred. Even if all other calls were successful, which is extremely unlikely, the office would still only have an NER of only 54%. Thus, one cannot make any qualitative judgment from ASR or NER without additional context. 54% could be a fantastically good ratio. Likewise, it could be poor. In particular, the signal of a true RCC failure could be totally lost in the noise of the robocallers. When single numbers and single pairs of numbers can and do have such an exaggerated effect on the ratio-based metrics we believe it obscures these metrics' ability to identify which parts of the network are truly having problems. Except in cases of obvious network congestion, we never saw any cases where calls to certain OCNs or end offices were affected across the board in terms of low NER or ASR, as we would expect if the network itself had problems delivering calls in RCC-type ways and these metrics captured those problems. These numbers were usually dragged down by robo-callers, terminating numbers with individual NERs of zero,[32] or machine retries.

3 Motivations for Developing HMR

These various problems and false alarms caused by complications with the ratio-based metrics led us to think of different methods for analyzing network performance. One of our first thoughts was to create black lists of potential robo-callers and disconnected numbers which we would then filter out of our calculations any call whose originating or terminating number, respectively, fell onto those lists.[33] As described in an earlier anecdote, these simple adjustments vastly improved how the network looked in terms of performance in NER. In fact, the apparent network performance improved so much that we suspected we were filtering out too many calls from our calculations. Unfortunately, we did not get more historical data to further refine our black lists for filtering so

[29] This is not an entirely accurate name, as it is unclear why exactly these retries exists, the 'machine' in the moniker is merely to denote that these retries are done so rapidly that they could not be due to a human redial.

[30] We have seen machine retries with standard codes 1 and 17 and even, in a few cases, code 16.

[31] Think of an end office as a smaller version of an OCN. As the OCN is to a state, the end office is to a city.

[32] Thus, having a higher probability than normal of being disconnected numbers

[33] The method we used for constructing both of these lists was to consider an originating number that placed at least 1400 calls/day to be a robo-caller and a terminating number that had no answered calls in the set to be unassigned.

the only tweaks we have been able to make and analyze are slight changes to the criteria already described for data we already have, such as only excluding numbers with at least 10 total calls, all unanswered, as disconnected numbers.

In any event, a static list of bad numbers will not work. This is because new robo-callers can pop up at any time. More insidiously, unscrupulous robo-callers can spoof their numbers and rotate them.[34] As such, it is important to derive dynamic identification of bad numbers.

There were other reasons beyond the data issues for us to develop new metrics. Mainly we were motivated by the idea that Rural Call Completion issues might be caused by "bad actors," like the hypothetical unscrupulous LCRs described in the introduction, and, as such, release codes and answer signals should not necessarily be trusted. Given the FCC reports that an LCR has played treatments or rings for calls when they are not supposed to and other reports of calls where one party or the other cannot hear anything from the second they connect, it is reasonable to believe that false answer signals from unscrupulous LCRs is a possibility. According to our industry contacts, they have never seen false answer domestically, though they have seen it in international calls, meaning it is technically possible, even if such false answers do not exist in the domestic PSTN. Given that possibility and known issues with signaling for disconnected numbers, we wanted to develop a metric where even if a call has a good release code and has an answer signal, that does not mean the call is automatically considered a success. Likewise, a call that has a bad release code is not automatically considered a failure. We wanted to create a metric as independent from signaling as possible.

Our first step to reaching this goal was to think of the symptoms of RCC and how callers experiencing these symptoms would respond. All of the symptoms share the trait that the call abnormally fails in a way that is obvious to the caller. A caller does not expect to hear silence when they place a call, they do not expect 10 or more rings to occur, they do not expect to hear sound so garbled they cannot hear anything, and they do not expect to hear a message saying, "your call cannot be completed as dialed" when they were able to connect just the week before. For every RCC symptom we have heard of, with the possible exception of a multitude of rings or perhaps a busy signal, we would expect the caller to try the call again in short order, perhaps waiting a few minutes or perhaps calling back immediately. As such we wanted a metric that would capture when people retried calls rather quickly due to these obvious failures without also capturing the machine retries we discussed above.

4 Description of and Results for HMR

The metric we developed, Human Retries, or HMR for short, is a flexible measure of whether a call was retried or not. The metric starts as a record-by-record feature, classifying each record by whether the call record has another call within a short time window after it. To do this, our implementation of HMR set the default value for HMR as No and then scans subsequent records for calls with the same originating and terminating numbers as the call in question. If any of the records with the same telephone number pair fall between 13 seconds and 3 minutes after the first call, we set its HMR to Yes. In our observations of the data it takes low volume callers at least 13 seconds to retry a call. This heuristic comes from the time for a person to realize that the call has failed, hang up, and then redial. Three minutes allows the caller to leave some time to "let things sort out" but hopefully excludes situations where the caller experiences an expected failure, such as a ring no answer where the caller decides "they're probably not home, I'll try again in a bit." Of course, it may be normal for people in such ring no answer situations to call twice or more before "giving it some time," but this situation is built into the aggregating of calls with Yes for HMR, which we will get to in a bit. This initial calculation is by far the most computationally expensive but once the HMR is set it can be modified very easily. For example, if a carrier wants to apply the black lists we

[34] E. Burger and J. Kieserman, "Next generation caller identification," S²ERC, Tech. Rep., Jun. 2016. [Online]. Available: https://s2erc.georgetown.edu/sites/s2erc/files/files/upload/stir_status_and_analysis.pdf (visited on 03/10/2017).

described earlier they can simply set back to No any call marked with a Yes whose numbers fall into one of the black lists. Alternatively, a carrier may want to only consider unanswered calls, or calls with less than a certain amount of talk time, or only code 16, or only calls not receiving busy signals. The only place the metric is not particularly flexible is in changing the time window for what we consider retries. We are confident in the reasoning behind the 13 second to 3 minute time window[35] but re-calculating the HMR over larger datasets takes quite some time so it is possible the metric could be more useful with a wider or possibly shorter time window. More research, plus validation in an actual networking environment, is needed to determine the relative efficacy of different time windows.

As a trade-off for being rather simple to calculate, HMR counts a lot of things as having human retries that it, as far as the theory goes, should not. For an example, we will go back to the 428 calls in 7 minutes. While it is fairly obvious that these calls are machine rather than human retries, the sheer length of the burst of calls defeats our simple calculation. With about one call per second, the very first call does not initially consider itself to have a retry until the scan hits a call with the same phone numbers outside of the 13 second range. There are so many calls though that all but the final 13 or so calls will be marked as Yes. One way to overcome this problem would be to only set HMR as Yes if there does not also exist what we would classify as a machine retry (i.e. within 5 or so seconds), but this method would make an already somewhat time consuming calculation even more time consuming. Alternatively, using number black lists would rule these out as well, since the terminating number with the myriad retries is on the list using our simple method for determining disconnected numbers.

The larger fix for this problem gets to how we think HMR should be aggregated and how it should be used to evaluate network performance. Once the individual HMRs have been calculated and filtered, they can be aggregated in different ways, much like how the ratio-based metrics can slice data along different lines of both time and location. We have been talking about HMR so far as a sort of a raw count, e.g. there were about 400 retries for this one number pair and we are going to count all of them towards the aggregate for whatever slice (OCN, hour, office, day) we are considering. We could also aggregate along each pair of originating and terminating numbers which are experiencing retries. This way, the 400 retries would only count once towards the aggregation. The idea here is that if the network or an LCR is having RCC-like issues delivering calls to a certain area then multiple different pairs of numbers are going to experience those symptoms and thus have retries. We expect that in some cases the raw number of retries will not tell us as much about performance as how many different calls are experiencing conditions that cause retries, especially given situations like burst calls. We have seen cases of 'machine' retries which are not caught by either of the black lists we have built and thus would need one of the more complicated methods to be filtered out, but aggregating on pairs of numbers with retries rather than total retries reduces their influence on the metric. Without testing, deploying, and refining in an actual network environment, though, it is hard to say what exact method of aggregating retried calls would be most informative.

Though giving a full evaluation of the usefulness of the metric and its different methods of aggregation is not possible without deployment, our initial investigations have revealed that while there is some overlap between when HMR and NER perform poorly,[36] HMR is capable of uncovering phenomena that NER cannot. Before going forward with these comparisons we should note that the form of HMR being used for these comparisons is the percent of originating/terminating number pairs having retries. Raw counts of retries do not make sense for a comparison of NER and HMR, as counts vary much more with call volume than ratios do. Using the ratio of calls that are retries to all calls has some obvious risks of overlap with NER, as in the example discussed above, where a large number of retries to the same number receiving any code other than 1 is going to drive NER down and HMR up. The ratio of number pairs receiving retries to total pairs (we will refer to this as pair HMR from here out) does seem to still have some entanglement with NER, as we shall see soon, but it also seems capable of uncovering issues invisible elsewhere. We will now go into some

[35] Though the 3 minutes limit is based somewhat on conjecture and might make sense to be refined.

[36] I.e., high HMR and low NER.

further detail on how NER and pair HMR compare to each other in our data and then follow that up with examples of pair HMR finding issues where NER would have sufficed and finding a change that NER could not have captured.

An examination of monthly NER vs pair HMR for each OCN reveals that, on average, a 1 unit increase in NER ratio results in a 9.35% decrease in the odds[37] of retries to non-retries. For context, the mean pair HMR of among all OCNs is 7.35% and the mean NER is 63.62%. A change in NER from 63.62% to 64.62% would result in a change in pair HMR from 7.35% to 6.71%. Since one could consider pair HMR as a symptom of network ineffectiveness, it is not surprising to see that pair HMR decreases as the network effectiveness ratio increases. However, as the following plots illustrate, HMR can detect phenomena which are masked by NER. The plots below are time-series of daily pair HMR and NER calculations for a single OCN located in north-central Indiana. One can clearly see large spikes in the number of unique number pairs with retries in the month of October, while there is relatively small effect on NER. In fact, the *AnomalyDetection*[38] tool does not classify the decrease in NER corresponding to the pair HMR spikes as anomalous. Additionally, there are negative spikes in NER which do not coincide with positive spikes in pair HMR, as can be seen at the end of August.

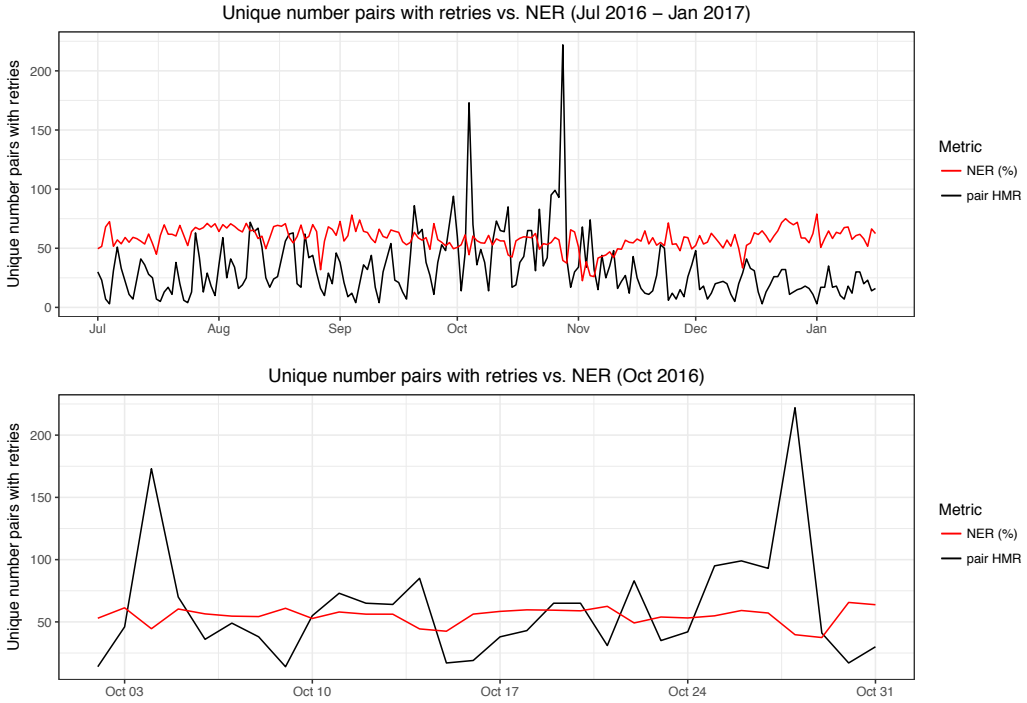


Figure 1: Time-series of daily pair HMR and NER for a single OCN.

[37] If $p = 0.05$ is the probability of being a retry, then the odds of retries to non-retries is $\frac{p}{1-p} = \frac{.05}{.95} = \frac{1}{19}$. Colloquially, we would say that "the odds of being a retry are one in nineteen."

[38] See Section 5 for discussion of the *AnomalyDetection* tool.

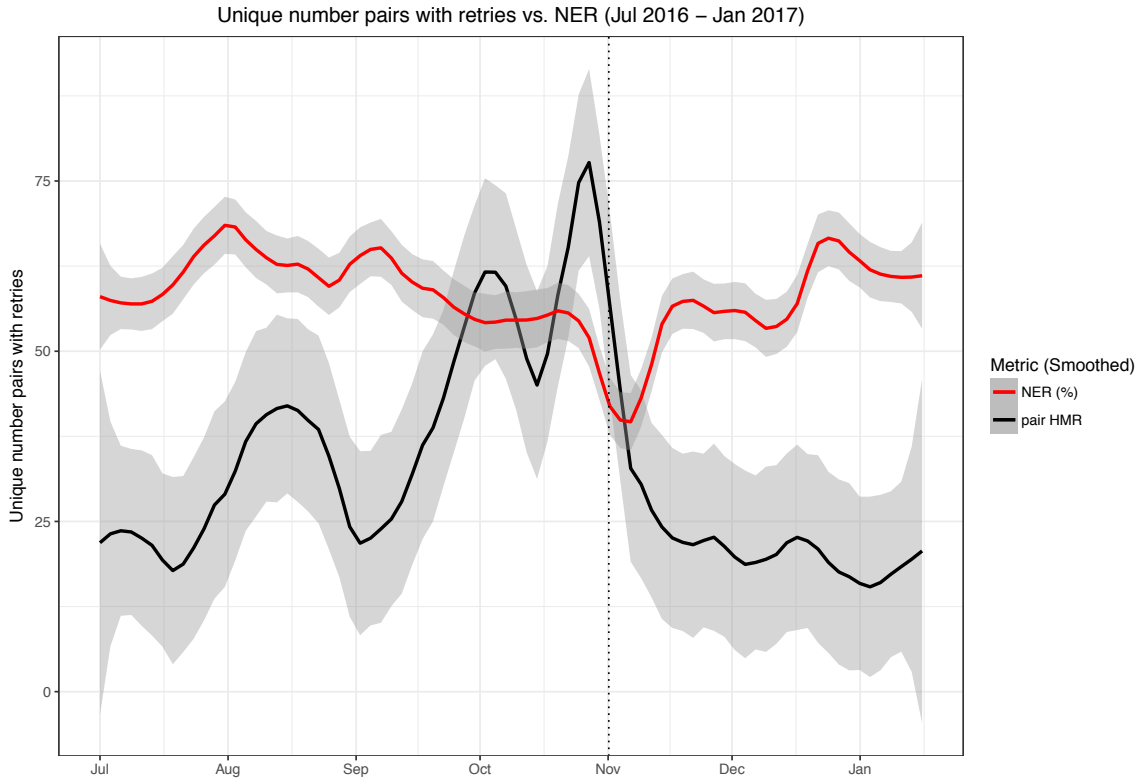


Figure 2: Smoothed time-series of daily pair HMR and NER for a single OCN.

Applying loess-smoothing to the time-series reveals the approximately inverse relationship between the two metrics more plainly. However, the relationship is not perfectly inverse, so there is clearly information which each captures that the other does not. The dotted line in figure (2) indicates where we detected a change in routing, which coincided with an immediate and sustained recovery in both pair HMR and NER from the degraded performance throughout the month of October. However, when we consulted the carrier and dug a little deeper into the data, we found that the degradation in the metrics was driven by a drastic decrease in call volume from one particular number. This number appears to be owned by a company in the political sphere and, unsurprisingly, had its call volume to this OCN drop after November 10. Though we believed we had uncovered an unexpected trend and recovery in HMR fixed with a routing change, the issue was once again seems to have been due to the composition of the callers rather than any other factor.[39] We also examined the proportion of unique number pairs with retries among all calls. Similar to NER, the proportion accounts for traffic volume, and provides a more interpretable measure of retry occurrence, though it too can be sensitive to the effect of robo-callers.[40] For example, one of our OCNs looked rather typical for all of the months that we have records except for one. In those months the OCN had an average pair HMR of 7.29%, which is quite close to the mean pair HMR for all months, but for the outlier month the OCN had a pair HMR of 19.83%. Zooming in, this OCN had a pair HMR of 48.76% on the 23^{rd} of the month in question. However, when we decompose how the individual call pairs with retries break down by originating number, we see that a huge percentage of the calls are coming from just two numbers.

[39] The carrier in question did in fact change its routing just prior to the spike in pair HMR / negative spike in NER. However, the focus here is on the change in the values of pair HMR and NER, not on the routing change.

[40] A robo-caller which retries a few numbers many times will cause a low pair HMR proportion. Conversely, a robo-caller which retries many numbers only a few times will cause a high pair HMR.

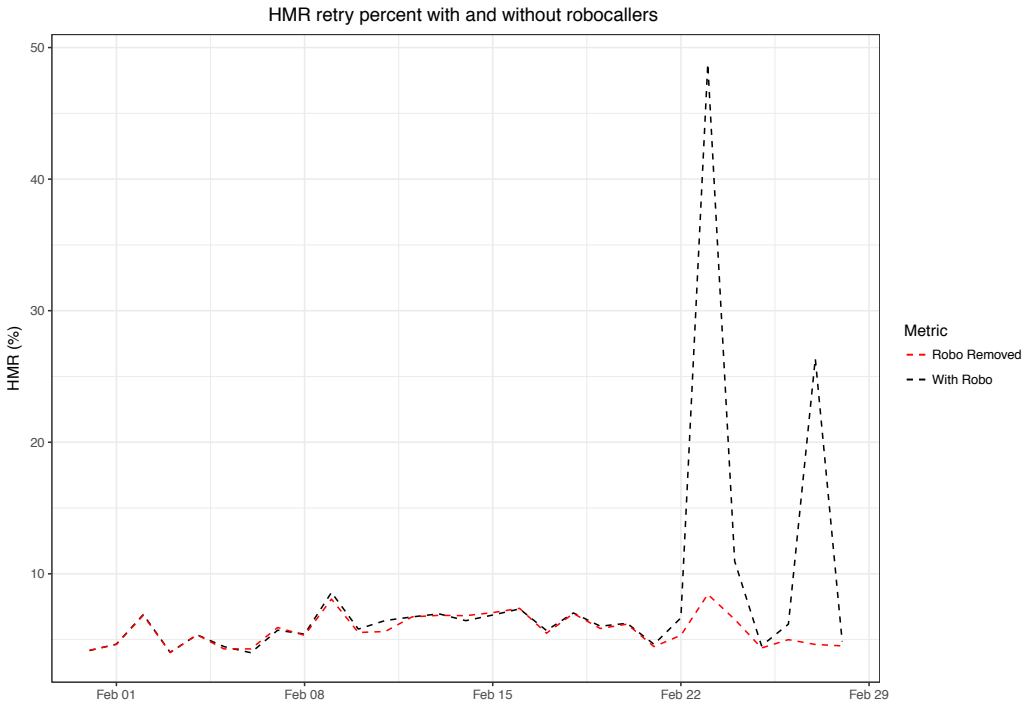


Figure 3: Time-series of daily pair HMR with and without robocallers for a single OCN.

In fact, 4247 of 5933 total call pairs for the day come from those two numbers, and 2754 of 2893 call pairs with retries on those days. Removing the call pairs including these two numbers, which we should note are both classified as robo-callers by the methods described above, improves the pair HMR for the day from 48.76% to 8.24%, much more in line with the average for the other months. There is only one other day in that month with a pair HMR of greater than 9% and, unsurprisingly, the same two robo-callers have a huge impact on the OCN for that day as well. So even pair HMR is affected by robo-callers, and so building good methods for filtering robo-callers is still going to be necessary to get the noise out of the data so carriers can focus on real network impairments.

5 Analysis Methods and Tools

5.1 Anomaly Detection

The temporal nature of CDRs lends them to time series analysis. Business cycles and the human circadian rhythm impose weekly and daily patterns, referred to as seasonality, to call volume and frequency. In turn, any metric based upon call volumes or frequencies will also display seasonality. Like a heartbeat or the stock market, these metrics can be examined for long-term and short-term trends. Through a process called time series decomposition,[41] we break down a monthly or weekly series of measurements to identify patterns, and develop de-trended mean values against which to judge deviation. Once we have identified normal patterns, we can then identify abnormal local and global deviations, or anomalies.

This is the underlying idea of Twitter's open-source *AnomalyDetection*[42] package that we use

[41] R. Cleveland, W. Cleveland, and I. Terpenning, "STL: A Seasonal-Trend Decomposition Procedure Based on Loess," *Journal of Official Statistics*, vol. 6, no. 1, p. 3, 1990.

[42] A. Kejariwal, *Introducing practical and robust anomaly detection in a time series*, 2015. [Online]. Available: https://blog.twitter.com/2015/introducing-practical-and-robust-anomaly-detection-in-a-time-series (visited on

in order to detect anomalies in network metrics. Within this algorithmic framework, anomalies are positive or negative deviations from de-trended means. An example of a positive anomaly might be a burst in call volume from a particular OCN driven by an auto-dialer. Likewise, a negative anomaly might be the sudden decrease in NER caused by the same auto-dialer.

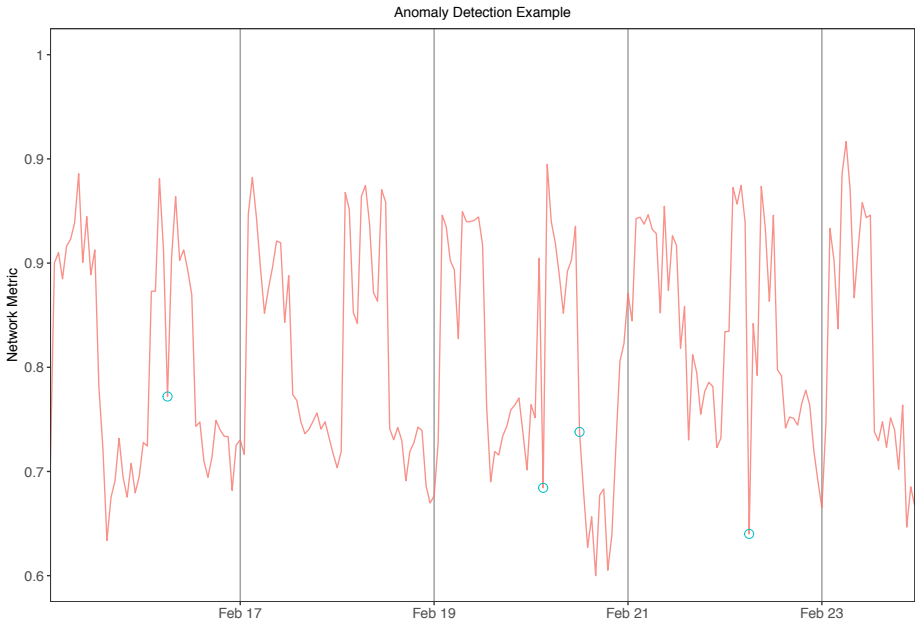


Figure 4: Example plot of *AnomalyDetection* output.

As-is, Twitter's *AnomalyDetection* package is only useful for analyzing historic, windowed data, and not as a real-time detection tool on streaming network data. Suppose that a network is collecting records and batch-processing the CDRs on an hourly basis. One possible ad-hoc method to adapt the algorithm to "real-time" analysis is to append the new batch of CDRs to the previous hour of records and perform the analysis. While hourly is certainly not real-time by most accounts, given the current pace of records analysis in telecommunications networks, usually on a monthly or daily basis, this ad-hoc method is certainly an improvement, and can be integrated into existing analytics regimes such that it operates automatically. We performed an experiment on our hardware to test the general feasibility of calculating HMR as records come in, assuming 5 minute intervals of data. We built a randomized sample of records sized as large as the largest 5-minute interval from the 5 month dataset, as well as an actual 5-minute sample of approximately the same size. Creating a index on the number pairs (necessary to optimize HMR calculations) and calculating the HMR for the records took 16 seconds for the randomized sample and 4 seconds for the real sample.[43] While the time to carry out these calculations will vary greatly from carrier to carrier based on hardware capability and database setup, our experiment at least shows that HMR could theoretically be calculated as records come in, at least in some setups. Given appropriate and informative metrics, AnomalyDetection, or a similar algorithm, can alert engineers to problems in the network as they occur, or within an acceptable window of time. We believe HMR, in its various forms, to be a useful metric to which anomaly detection may be applied, and would fit into the ad-hoc framework.

03/10/2017).

[43]We used a virtual machine running over VMware on a Cisco UCS B200 M3 blade with 2 vCPUs allocated to the virtual machine. The underlying, shared hardware is a dual Intel Xeon E5-2680 running at 2.7 GHz with 8GB RAM allocated to the virtual machine.

5.2 Retry Prediction

As discussed in the sections covering HMR, the retry metric is hypothesized to be useful for uncovering instances of rural call completion problems. In order for this metric to be more useful in a production environment, we would like to move from examination of historical records to real-time analysis or prediction. Similar to the problems with anomaly detection, we required a window size of 3 minutes to classify retries. Calculating this for each number pair on an ongoing basis would require a significant amount of computational power dedicated to the task. A more useful and economical alternative is prediction. Once we had classified the retries based on historical data, we then used machine learning methods to train a predictor model. Several methods were explored, each giving varying degrees of predictive power. In selecting the best model, a number of factors were considered. First, the model needed to be generally applicable. That is, it needed to be designed in such a way that it could be deployed on any network with little modification. Next, it should be designed in a way that it can be deployed at any level within a network's infrastructure. Finally, given the sheer volume of data flowing through a network at any given time, the model needed to have a high level of specificity. Suppose a predictor were able to catch 90% of the retries as they occur, with a 1% false-alarm rate. Further suppose we are classifying 100 calls-per-minute. With a false-alarm rate of 1%, that amounts to 60 false-alarms every hour. In the grand scheme, we deemed such an error rate to be ultimately useless, and would likely be ignored.

Thus, the model that we settled on is based on gradient-boosted decision trees[44] using logistic regression. This predictor was able to achieve a sensitivity of 13-15% with predictor variables that were not specific to any network infrastructure, while maintaining specificity at or above 99.7%. We found that the most predictive features are time of day and terminating OCN, with the two largest OCN's in our dataset by call volume being most predictive.

6 Future Research

Having recently acquired a large amount of historical data, we would like to see how HMR and the various ways of aggregating it change over time. Does it change predictably over time or does it stay relatively stable. Are there unexpected shifts? Are there other complicating factors like there are with our ratio-based metrics or is it possible that HMR gets perturbed in ways that can reveal underlying RCC problems? Many of these questions would be best answered by carriers in the industry implementing the metric, but we have enough historical data now that we should be able to reach some more definitive conclusions concerning HMR with just a little more research. We have also begun experimenting with a method to identify and filter robo-callers based on a technique discussed in a 2013 journal article in the Proceedings of the National Academy of Sciences.[45] We deeply believe that improving methods for filtering noise in the form of calls from robo-callers and to improperly signaled disconnected numbers out of the data will go a long way to improving HMR and other existing metrics. Another idea we are in the early stages of exploring is to monitor fluctuations in the percentages of different result codes on smaller slices, such as LCR-end office pairs or looking for times when carriers have sudden changes in the code distribution during periods of high traffic. If unscrupulous carriers are falsifying signaling or playing the wrong treatments, especially during times of high traffic, we would expect to see changes in the codes for calls going through that carrier. One thing that makes real-time tracing of RCC problems difficult is when a call never reaches the rural carriers they are destined for, the rural carrier has no idea they did not get the call. Likewise, the originating carrier, if it receives any signaling or treatment, thinks the call has been properly handled. If an LCR is dropping calls or playing improper treatments,

[44] T. Chen and C. Guestrin, "Xgboost: A scalable tree boosting system," in *22nd SIGKDD Conference on Knowledge Discovery and Data Mining*, 2016.

[45] J. Zhi-Qiang, W.-J. Xie, M.-X. Li, B. Podobnik, W.-X. Zhou, and H. E. Stanley, "Calling patterns in human communication dynamics," *Proceedings of the National Academy of Sciences*, vol. 110, no. 5, pp. 1600–1605, 2013. DOI: 10.1073/pnas.1220433110.

neither the originating nor terminating side has a definitive way to be privy to the fact that calls did not go through without either complaints from customers or access to the other company's records. Better communication between the IXCs and rural carriers could also lead to tracking down and eliminating the machine retries we see all over the place in the data. We believe what we have so far with HMR is a promising, new sort of metric, one that could uncover issues invisible to metrics that rely on result codes and answer signals. Further refinement is needed, especially in filtering out numbers on both ends without over-filtering, but the metric measures calls in ways that traditional ratio-based ones do not, and attempts to identify RCC-specific problems in ways they cannot.

One question for research is whether the deployment of the all-IP telecommunications network will help or harm the RCC problem. One of the issues uncovered by our research is that some signaling anomalies stem from legacy class 4 and access tandem trunk configurations. It is not uncommon to find these configurations are running on 20-year-old equipment and provisioned as long ago. We believe a regulatory mandate to rural carriers or access tandem operators to harmonize signaling would be ineffective as it is likely that neither the personnel nor manufacturer support is available on this legacy equipment. We do believe that a move to the all-IP public network, using SIP in particular, affords an opportunity to apply upgrades and harmonization as needed.

Consider the common situation where a person calls a vacant number. The rural carrier returns a release code 1, but the access tandem starts to play SIT and a vacant number announcement. At this point in time, the caller hangs up the phone, sending a result code 16 towards the rural carrier. The result code 1 from the rural carrier is lost. In a full SIP interworking environment, if all intermediate paths return the 404 (Not Found), a 404 can go from the rural carrier to the originating carrier.

SIP is not necessarily a panacea. For example, just as there are literally hundreds of SS7/ISUP release codes, one area of research needs to be to develop uniform guidance on SIP configuration. For example, what if the ILEC configures a vacant number as 410 (Gone)? On the one hand, the originating carrier knows calls to that destination will fail just as they would for a 404. However, having two codes meaning 'vacant' leaves open the opportunity for interworking errors. Ongoing work in forums such as the NNI Work Group[46] needs to be done to ensure we do not repeat the mistakes of the SS7 network in SIP.

7 Summary

We described a novel network performance metric, Human Retries (HMR). HMR captures RCC issues missed by ASR and NER. We validated the operation of HMR on static data from three carriers, but we were only able to compare two full months of data.

As for next steps, the industry should ensure some of the research mentioned above is done. In particular, we are close to real-time HMR validation. It would be valuable to finish that work. As well, identifying and, better yet, dealing with robo-callers is important, valuable research as well. A step in that direction is the S^{2}ERC project *STIR Implementation*.[47]

Our task was to look at the RCC problem form the originating and IXC transport carrier perspective. However, as shown above, originating carriers have no idea if calls are truly being mishandled once they leave the carrier's network. We propose that we instrument the network at the point where we can detect call failure: at the rural carrier's interfaces with the rest of the public network. We can create tooling for rural carriers to detect deviations between normal call volumes and reduced call volumes. Note such tooling is not as straightforward as it sounds. Our expectation is again robo-calls will have a profound impact on any network health metric. In addition, such metrics will need to be cognizant of the general decline of wireline voice minutes and subscribers. We see this as interesting, important work to address a problem the FCC says impacts rural carriers

[46] *Atis/sip forum ip-nni task force*. [Online]. Available: http://www.atis.org/01_strat_init/IP-NNI/index.asp (visited on 03/10/2017).

[47] https://s2erc.georgetown.edu/projects/PSTNtransition/STIR

and thus rural Americans.

8 Acknowledgements

In addition to the support provided by the NSF under grant IIP-1362046, we would like to acknowledge the support and advice provided by the FCC Enforcement Bureau. In particular, the FCC assisted us with contacts at inter-exchange carriers that proved invaluable for us to get the data from which we built and verified our tools. We would also like to thank numerous individuals from Verizon, Level 3, and inContact for both providing data as well as making their engineers available whenever we had questions. We also appreciate the assistance provided by the NECA for giving us depth and context on Rural Call Completion problems and making some introductions to rural carriers for us. As stated above, the opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and not of any of the named companies, organizations, or government entities.

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[11] T. Chen and C. Guestrin, "Xgboost: A scalable tree boosting system," in *22nd SIGKDD Conference on Knowledge Discovery and Data Mining*, 2016.

[12] J. Zhi-Qiang, W.-J. Xie, M.-X. Li, B. Podobnik, W.-X. Zhou, and H. E. Stanley, "Calling patterns in human communication dynamics," *Proceedings of the National Academy of Sciences*, vol. 110, no. 5, pp. 1600–1605, 2013. DOI: 10.1073/pnas.1220433110.

[13] *Atis/sip forum ip-nni task force*. [Online]. Available: http://www.atis.org/01_strat_init/IPNNI/index.asp (visited on 03/10/2017).

EXHIBIT D

EXHIBIT D

Rural Call Completion

Industry Workshop II

March 29, 2017

verizon

Rural Call Completion Industry Workshop

Welcome!

Rural Call Completion Industry Workshop – Panel Discussion

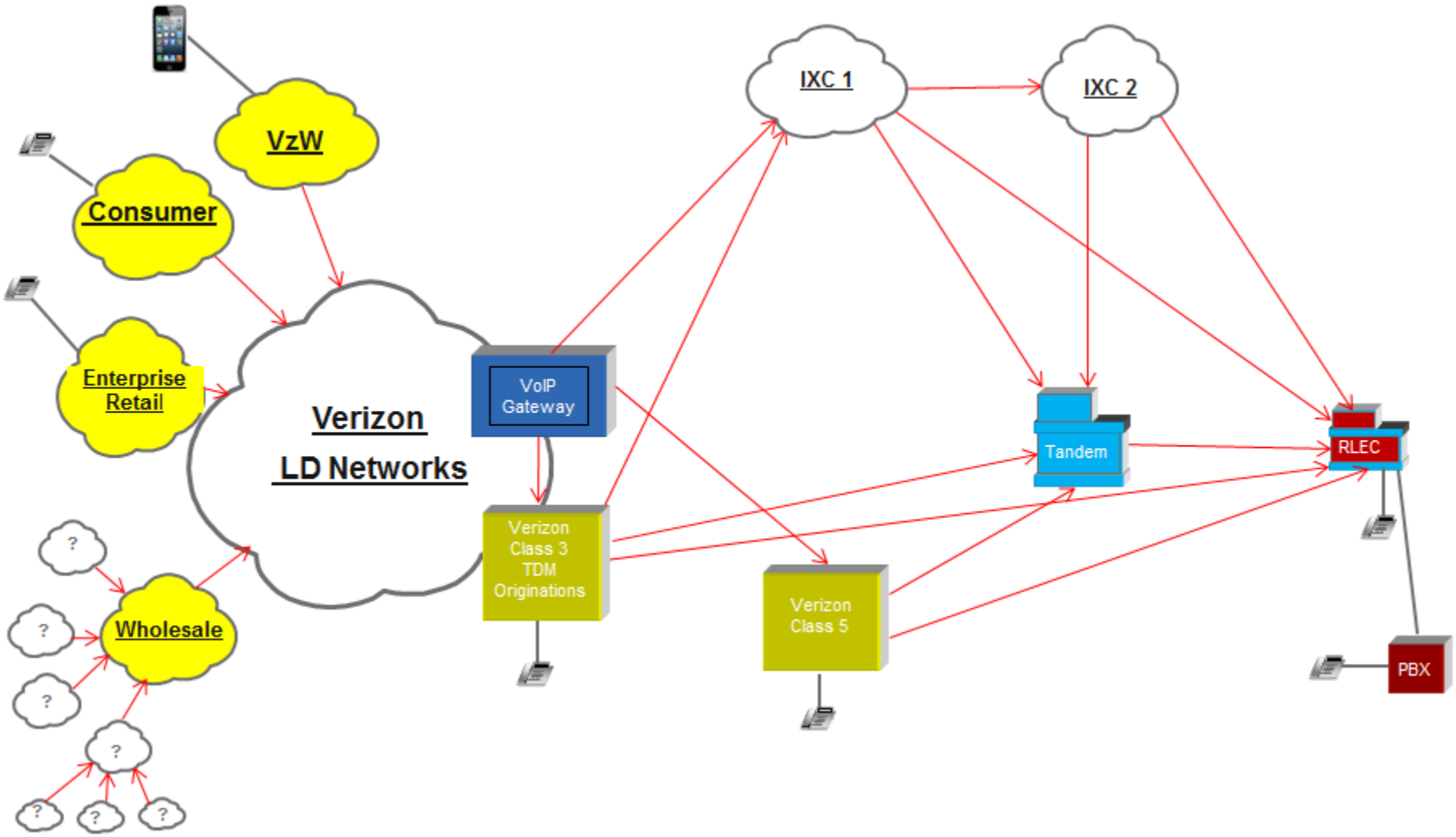
- **Limiting Use of Intermediate Providers**
- **Investigative Activities**
  - ASR investigations
  - Re-origination
  - Calling Party Number manipulation
  - Milliwatt testing
  - New metrics: Repeat Attempts Metric (RAM)
- **Responses to Complaints**
  - Overview of complaint-driven activities
  - Review of selected investigations

Rural Call Completion Industry Workshop – Panel Discussion

Limiting Use of Intermediate Providers for Calls to Rural ILECs

- Verizon implemented changes in its routing of calls to Rural ILECs.
- Verizon requires its intermediate providers to contractually agree to utilize no more than one additional carrier in routing before the call is delivered to the RLEC or the tandem for termination.

Rural Call Completion Industry Workshop – Panel Discussion



Rural Call Completion Industry Workshop – Panel Discussion

Answer Rate (ASR) Investigations

- **Metric: Answered Calls / (Total Attempts – Attempts to Unassigned Numbers)**
  - Answered call is a call that receives an answer message and a normal release cause code.
  - Attempts to Unassigned Numbers means call attempts with release cause code of 1.
- **Scope:** Call attempts to all OCNs designated as rural on the annually updated list published by the National Exchange Carrier Association (NECA).
- **Two types of triggers**
  - Monthly Low ASR: OCNs for which the Call Answer Rate fell below 80% of the Aggregate Rural Answer Rate in the prior month.
  - Next-Day Negative Spike: OCN with an Answer Rate that is one third or less of its 35-day rolling average Answer Rate for two consecutive days.
- **Up to Twenty Investigations Per Month**
- **Did not filter out autodialer traffic**

Rural Call Completion Industry Workshop – Panel Discussion

Overview of ASR Investigations

- **Time Period**
  - April 2015 through December 2015
  - Total Number of Investigations: 202
    - Low ASR: 176
    - Negative Spike: 26

Rural Call Completion Industry Workshop – Panel Discussion

Overview of Low ASR Investigations

Signaling Practices	***OCNs***	***%***
Cause Code 1 in ACM	30	
Unexpected RWC	83	
EO Non-SS7	22	
		77%
Calling Patterns		
Autodialer	11	
Mass Call	7	
Single number	2	
		11%
Other		
Translations	1	
Verizon Network	1	
No Issue Found	8	
Misc	1	
End Office outage/isolation	10	
		12%
Total	176	100%

Rural Call Completion Industry Workshop – Panel Discussion

Overview of Negative Spike Investigations

- 26 OCNs tripped the Negative Spike metric.

Outage/SS7 Isolation in RLEC Network	7
Autodialer Event	6
Mass Call Event	5
Single Number Issue	5
End Office not SS7	1
Incorrect Release Message	1
No Issue Found	1
Total	26

- 73% of negative spikes were due to calling patterns.
- When we contacted the RLEC for the 7 RLEC network events, the RLEC was already aware of the event (internal alarms, etc.). These were power, transport, or switch outages.

Rural Call Completion Industry Workshop – Panel Discussion

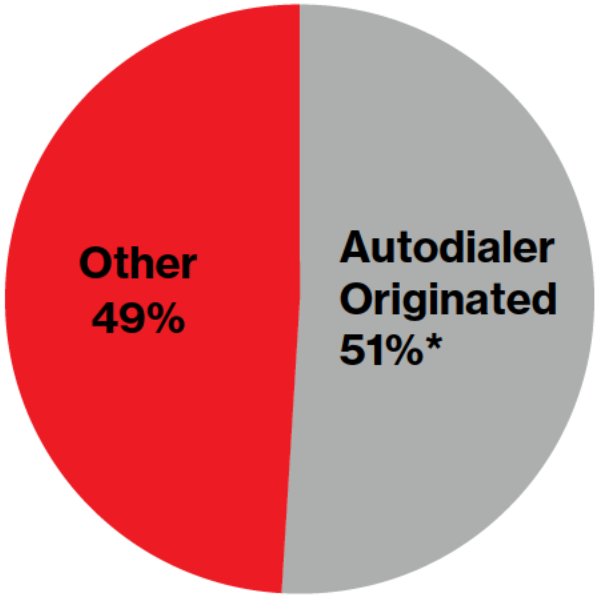
Observations

- **OCN vs. CLLI (end office)**
  - 47% of OCNs had 2 or more CLLIs (end offices)
  - 17% of OCNs had 5 or more CLLIs (end offices)
  - A low ASR for an individual CLLI can drag down an entire OCN
  - A high ASR for an OCN can mask a low ASR for an individual CLLI
- **Autodialer Activity**
  - Autodialer activity impacts answer rate (autodialers are a significant driver of unanswered calls).
- **Unassigned Numbers**
  - Calls to unassigned numbers impact answer rate (calls to unassigned numbers are unanswerable).
  - Release cause codes cannot be used to reliably identify all calls to unassigned numbers. Many call attempts to unassigned numbers result in a release cause code of something other than 1.

Rural Call Completion Industry Workshop – Panel Discussion

Autodialer Activity

- **Types of Autodialers**
  - Public service (weather alerts; school closings; etc.)
  - Telemarketing activity
  - Political / Campaign calling activity
- **Volume of Autodialer Activity**



*Based on 30-day data sample. Autodialer = Any calling number which has made >60 calls in any 1 minute period during the prior 90 days (inclusive of the investigation period).

Rural Call Completion Industry Workshop – Panel Discussion

Effect of Autodialer Traffic on ASR

- May generate multiple attempts (SIP proxy retries).
- High volumes cause network congestion, causing other non-autodialer call attempts to fail.
- Autodialers place significant volumes of calls to numbers that are not in service (can't ever answer).
- Autodialers generate call-back activity to numbers that are not in service or that otherwise don't answer.
- Autodialer campaigns are often of short duration, but can have a lingering impact; a one- or two-day autodialer event can skew the Answer Rate for a destination for the entire month.

Rural Call Completion Industry Workshop – Panel Discussion

Calls to Unassigned Numbers

- **Unassigned numbers cannot be accurately identified solely by relying on the Cause Code in the ACM or Release Message**
- **Signaling Framework**
  - Cause Code "1" is designated by industry standards to indicate the Called Number is unassigned (not in service).
  - ACM (Address Complete Message). Sent by downstream carrier to instruct upstream carriers to open audio path. Results in caller hearing "announcement" for calls to unassigned numbers when no ANSwer message is generated.
  - ACM messages may optionally contain a cause code.
  - RELease message. Sent by carrier whose party hangs up first. Cause code is required.
  - Cause Code in ACM will differ from Cause Code in RELease message.

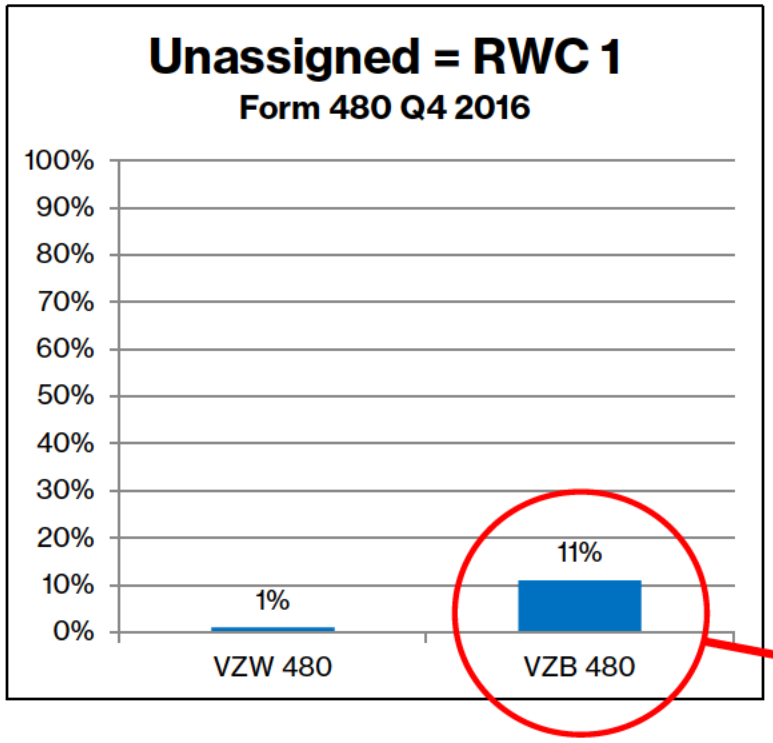
Rural Call Completion Industry Workshop – Panel Discussion

Calls to Unassigned Numbers

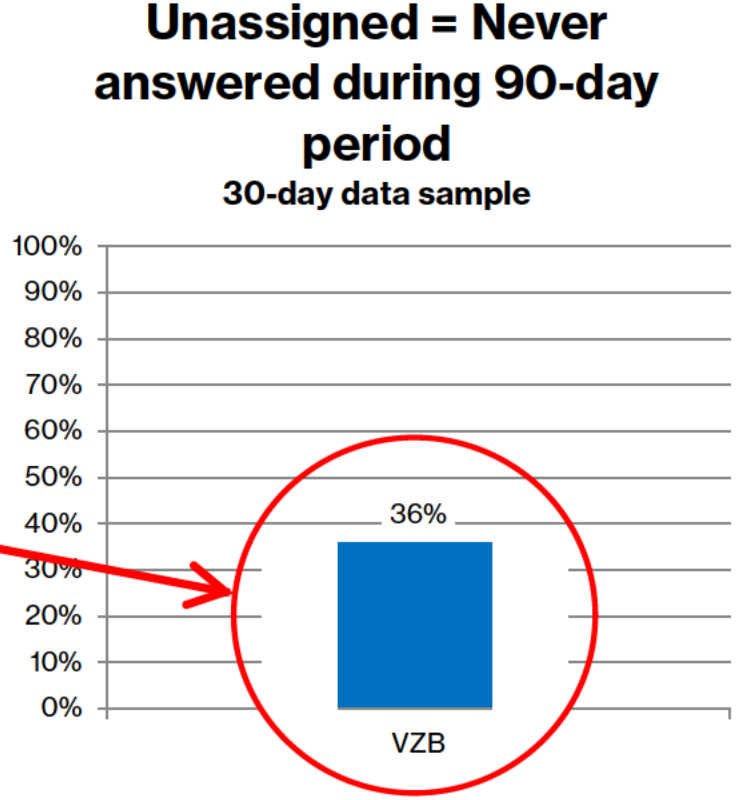
- **Signaling practices observed for calls to unassigned numbers**
  - RLEC sends RWC(1). If passed back to originating carrier, originating carrier should play the announcement.
    - Sometimes tandem or IXC intercepts the RWC(1), provides an ACM upstream, and plays an announcement for the caller. Typically results in RWC(16) from originating carrier when caller hangs up.
  - RLEC sends ACM(1), and plays announcement itself. Typically results in RWC(16) from originating carrier when caller hangs up. But ACM cause code (1) indicates called number was unassigned.
  - RLEC sends ACM(blank), and plays announcement itself. Typically results in RWC(16) from originating carrier when caller hangs up. Originating carrier does not have visibility to the fact that the called number is unassigned.
  - RLEC sends cause code other than (1) in Release message (e.g., 3). Can drive different treatments or announcements in upstream networks. Originating carrier does not have visibility to the fact that the called number is unassigned.
- **Verizon contacted the RLEC on 168 investigations. 137 of those were the result of not having received a RWC (1).**

Rural Call Completion Industry Workshop – Panel Discussion

Originating customer mix, not network or terminating destination, is what drives % of calls to unassigned numbers.



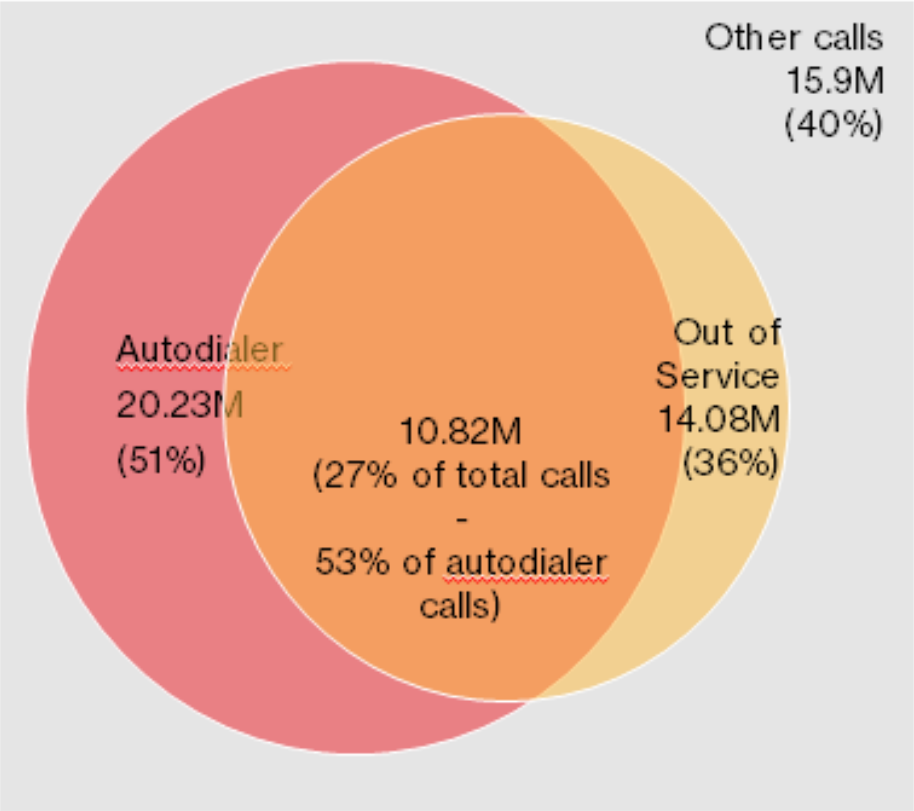
Relying solely on RWC 1 undercounts calls to unassigned numbers



verizon

Rural Call Completion Industry Workshop – Panel Discussion

Autodialers frequently call unassigned numbers.



Out of 39.43M calls in study period*:

- 51% were made by autodialers
- 36% were made to out of service (unassigned) numbers
- 27% were made by autodialers calling out of service numbers
- 53% of autodialer calls were made to out of service numbers
- 77% of calls to out of service numbers were made by autodialers

* Based on 30-day data sample. Autodialer = Any calling number which has made >60 calls in any 1 minute period during the preceding 90-day period. Unassigned = Number never answered during preceding 90-day period.

verizon

Rural Call Completion Industry Workshop – Panel Discussion

Low Answer Rate Investigations

- **Answer Rate investigations did not identify the type of LCR activity that is suspected to be at the root of systemic rural call completion failures.**
- **We enhanced our data collection to include**
  - Address-Complete Message (ACM)
  - ACM Cause Code
  - Direction of Release Message

Rural Call Completion Industry Workshop – Panel Discussion

Calling Party Number (CPN) Manipulation

- May be used to disguise source of call
- May be used to engage in arbitrage

Verizon conducted investigations call re-origination

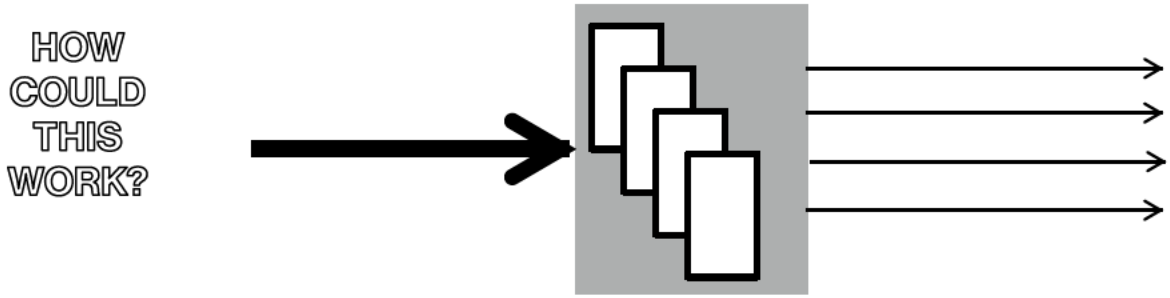
- SIMBOX fraud
- Wireline VoIP Services

Verizon conducted a CPN manipulation study

- Calling studies to try to identify instances of CPN manipulation

Rural Call Completion Industry Workshop – Panel Discussion

SIMBOX "Re-origination"



Theory: Analytics method to look for re-originated calls using SIMBOX (VZ CDMA or VoLTE) based upon Network Data (Realtime and post-call Metadata Analytics of Billions of Records)

Model 1: *Identify Mobile Device (MDN) that generates statistically significant minutes of use to Rural Locations, cross-reference MIN/IMSI/IMEI*

All Calls > Only Rural Destination > Dur/Count by User > Graph Count/Dur

Model 2: *Cell Site / Sector that generates statistically significant minutes of use: If the users weren't optimized, what about looking for cell density (Rural termination from ANY origination taking into account AYCE voice rating)...*

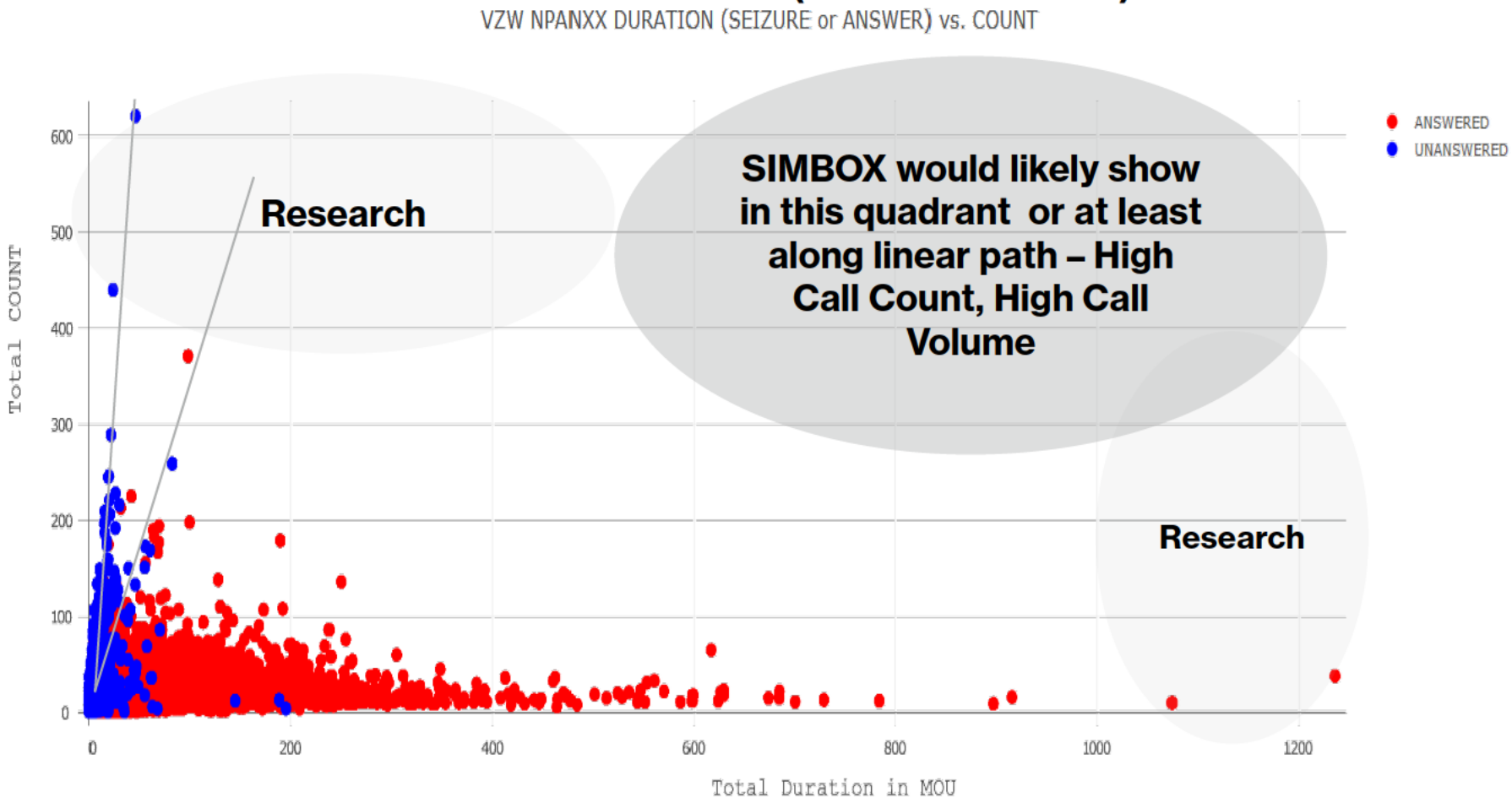
All Calls > Only Rural Destination > Dur/Count by CellSite > Graph Count/Dur

Rural Call Completion Industry Workshop – Panel Discussion

SIMBOX "Re-origination"

Model 1 : MDN Density for Rural Call

Each "dot" is a user that called a Rural NPANXX (duration is included)

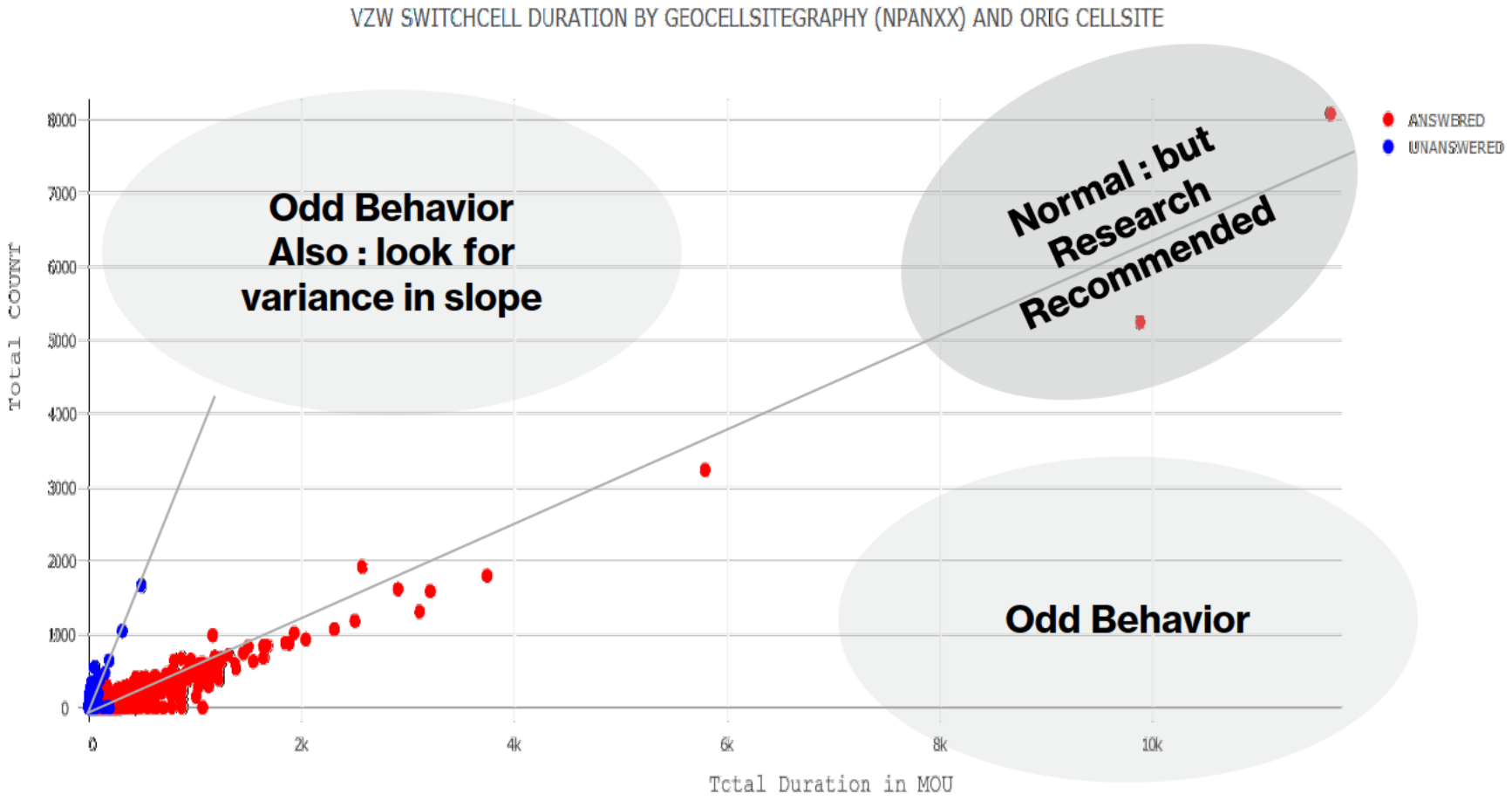


Rural Call Completion Industry Workshop – Panel Discussion

SIMBOX "Re-origination"

Model 2 : Whole Network Cell site Density Origin calls Rural NPANXX

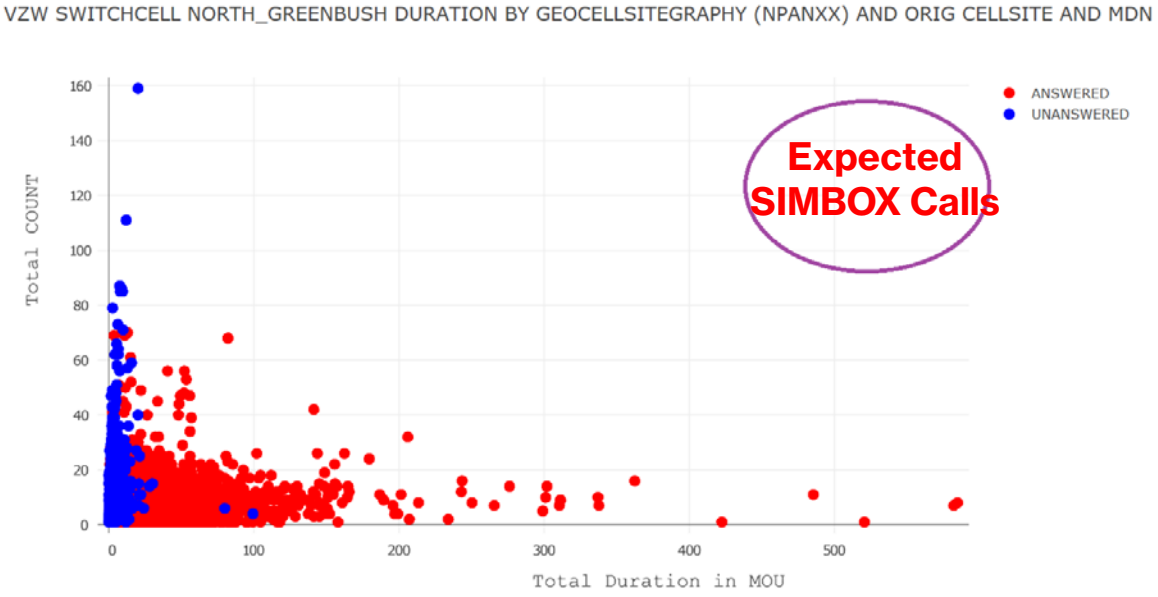
Each "dot" is a cell site that generated traffic to a Rural NPANXX (duration is included)



Rural Call Completion Industry Workshop – Panel Discussion

SIMBOX: Actual Implementation

1. Assumption: A SIMBOX is physically associated with one (1) cell tower. SIMBOX SIM cards are used to re-originate calls (new CPN) to take advantage of unlimited call plans.
2. Objective: Identify cell towers where multiple MDN's are making high volumes of calls with high volumes of minutes to Rural LEC CLLIs. 8,831 Cell Towers evaluated per week.
3. Result : 35 One-Week Evaluations Performed. No SIMBOX calling patterns found.



Rural Call Completion Industry Workshop – Panel Discussion

Wireline VoIP "Re-origination" (proof of concept)

Example: Verizon Retail Small-Business Customer

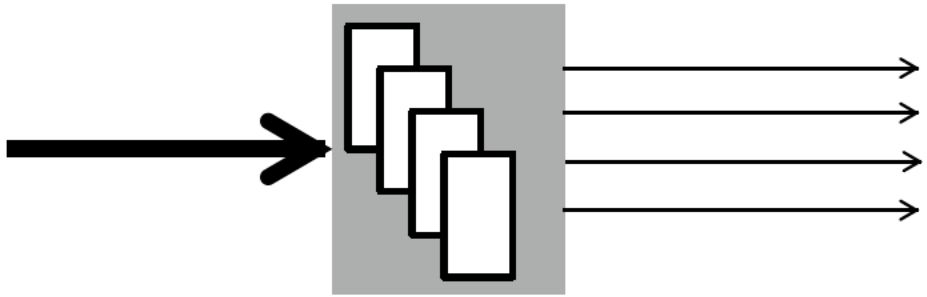
- Identified from RLEC test calls; complaint referred to Verizon
  - Test calls revealed change in caller-ID between call origination (non-Verizon Wireless handset) and terminating number (RLEC office number)
- At least seven different carriers in routing prior to Verizon
- Customer terminated by Verizon

Rural Call Completion Industry Workshop – Panel Discussion

Wireline VoIP "Re-origination" (proof of concept)

Attempt to identify usage of a "flat rated" voice plan to "reoriginate" minutes to Rural Locations

HOW COULD THIS WORK?



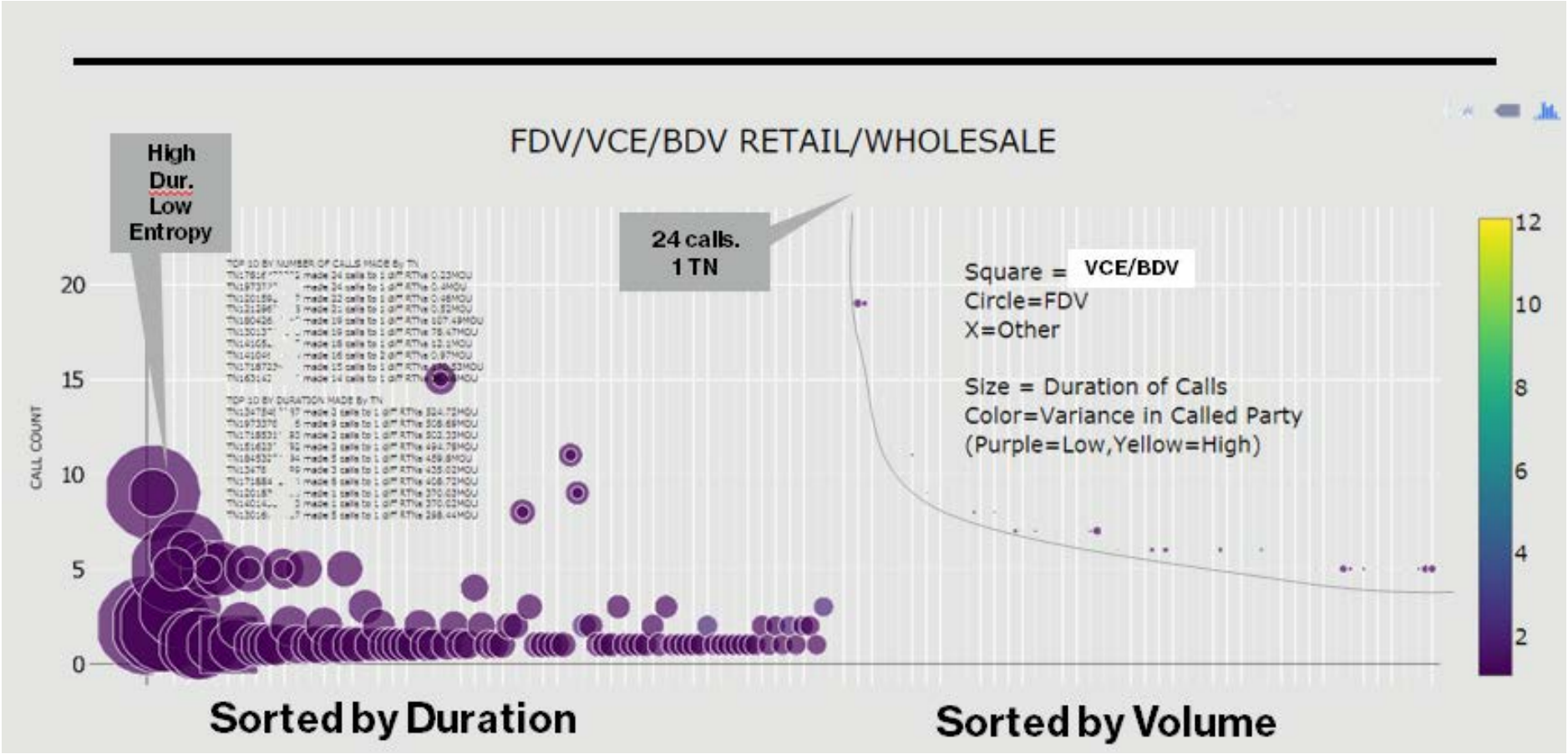
- Fios Digital Voice (Residential)
- Business Digital Voice (Small Business)
- Verizon Communications Express (Medium Business)

Other Carriers in Industry offer similar products

- Per 24HR of Realtime Signaling / CDR Records across ~6000+ NPANXX

Rural Call Completion Industry Workshop – Panel Discussion

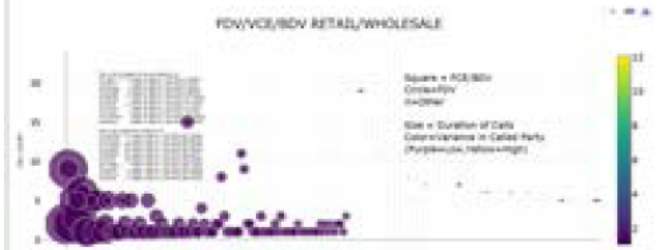
Wireline VoIP "Re-origination" (proof of concept)



Rural Call Completion Industry Workshop – Panel Discussion

Wireline VoIP "Re-origination" (proof of concept)

- What would retail customer's behavior have looked like on our sample report?



Rural Call Completion Industry Workshop – Panel Discussion

CPN Manipulation Study

- **Originated test calls to RLEC exchanges**
- **Compared records from origination and terminating tandem**

Origination	IXC Routing / Tandem	Number of Test Calls	Number of Instances where CPN Changed
Verizon Business local network switches	Various IXCs, Third-party tandem	2,588	None
Cricket, Magic Jack, T-Mobile, Boost Mobile, Google Voice, Consumer Cellular, Skype , Straight Talk, and Verizon Wireless.	Various IXCs, Verizon tandem	15,445	One*

*** CPN being changed by end-user of wholesale customer**

Rural Call Completion Industry Workshop – Panel Discussion

Milliwatt Testing

- Verizon maintains website to engage in milliwatt testing with any carrier.
  - Established April 24, 2015. One request received.
  - http://www.verizon.com/about/rural-call-testing
- During the 202 ASR investigations, Verizon initially requested the RLEC to engage in milliwatt testing as part of Verizon's investigation.
  - Of the 124 RLECs from which Verizon requested milliwatt testing, Verizon was provided with valid test numbers by 53 of them.

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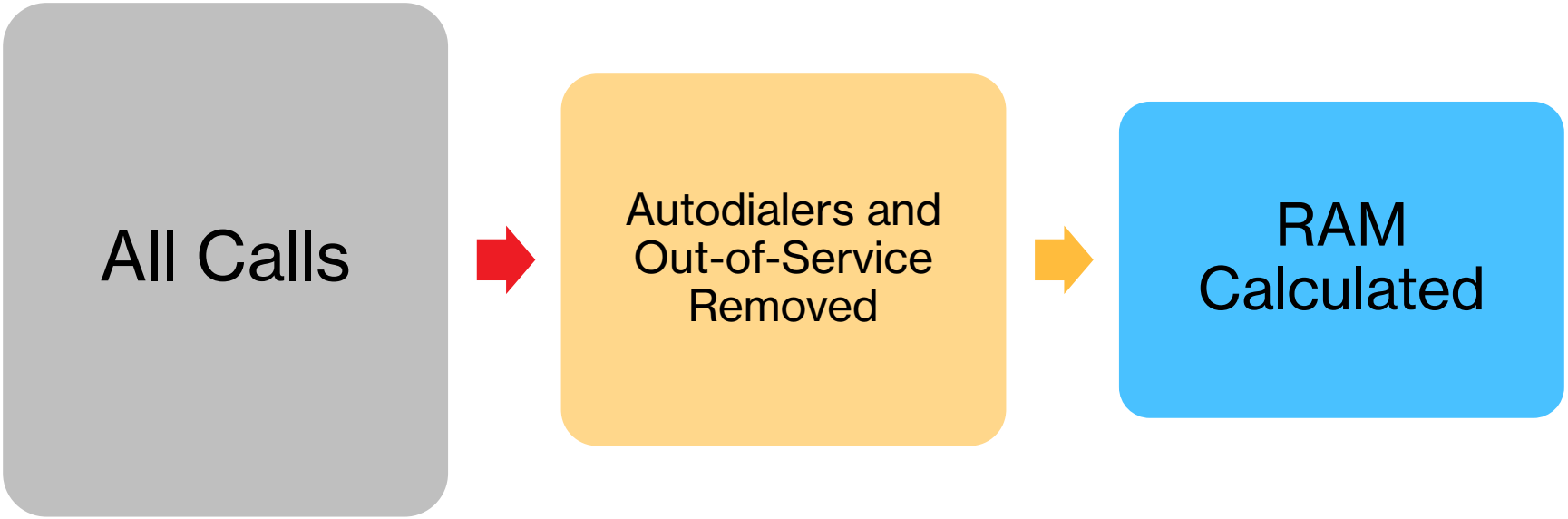
New Metric Being Pursued: **RAM (Repeated Attempts Metric)**



Rural Call Completion Industry Workshop – Panel Discussion

RAM Data Set and Assumptions

Time Period: First 10 days of a calendar month.

OCNs in Study:

Count of OCNs by State and Carrier-Type*

	Rural		Non-Rural	
	ILEC	CLEC	ILEC	CLEC
MI	29	2	0	0
MN	76	5	1	10
WI	62	5	0	0
IA	139	10	0	0

***Sample not statistically validated.**

Rural Call Completion Industry Workshop – Panel Discussion

RAM Data Set and Assumptions

Call Volumes:

10-Day Sample*	Total Call Attempts	Autodialers	Unassigned
Oct	11.7	5.8	4.3
Nov	15	8.1	5.1
Dec	12.7	6.3	4.6
Total	39.4	20.2	14.0

***Data in millions. Sample not statistically validated.**

Rural Call Completion Industry Workshop – Panel Discussion

RAM (Repeat Attempt Metric) Data Set and Assumptions

Calls (in scope) = Calls to in service numbers which are not from an autodialer

- Autodialer = Any **CALLING #** which has made >60 calls in any 1 minute period during the prior 90 days (inclusive of the investigation period)

- Out of Service Number (Unassigned) = Any **CALLED #** which has not answered a call during the prior 90 days (inclusive of the investigation period)

Repeated Attempt = 3+ calls between two numbers occurring in a 5 minute window

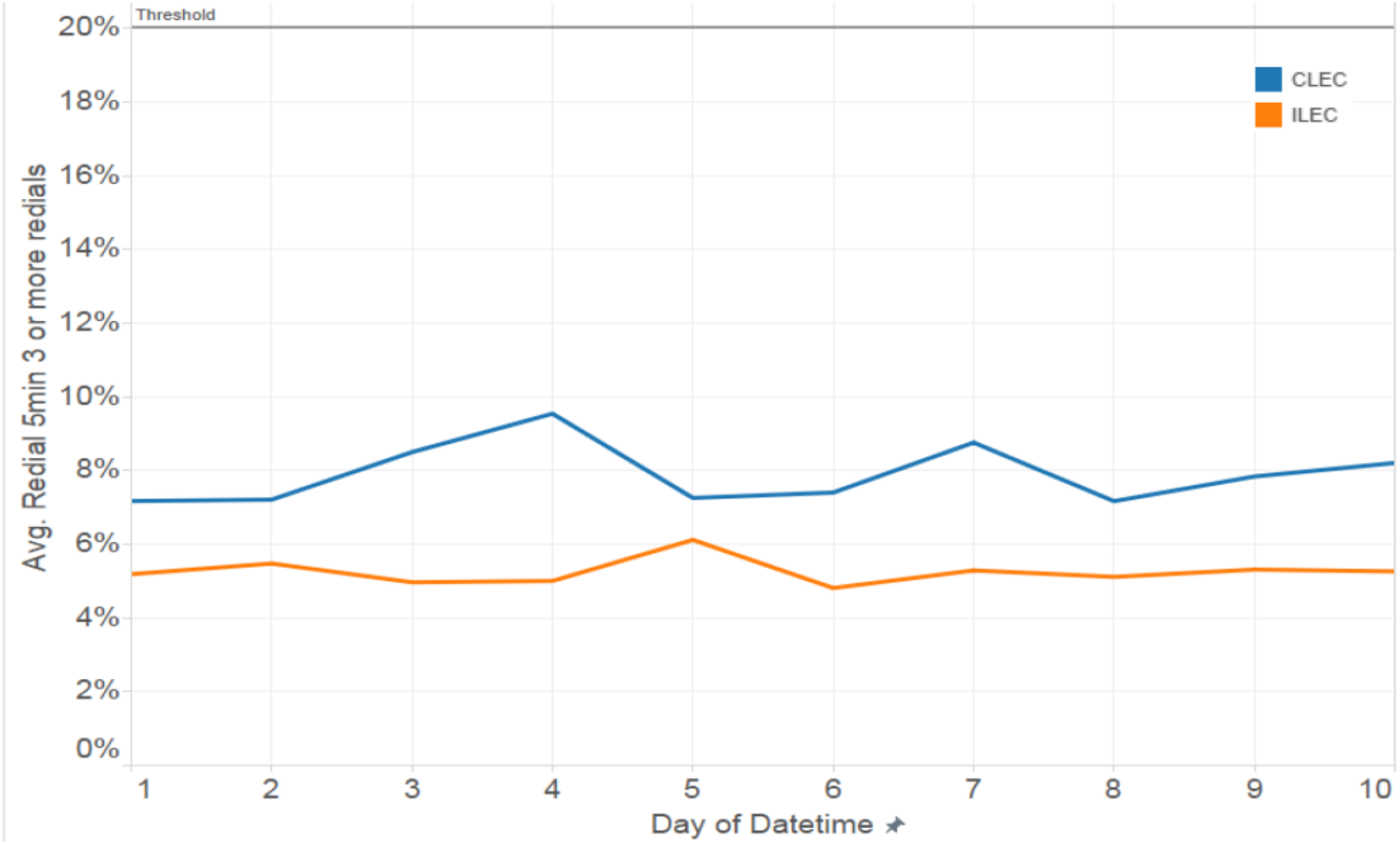
- Repeated Attempt Calls = Total # of calls made during all repeated attempts

- Repeated Attempts Metric = Repeated Attempt Calls / Calls (in scope)

Rural Call Completion Industry Workshop – Panel Discussion

RAM Investigations

- **In this sample, RAM generally runs in 5% to 10% range (December data).**



Rural Call Completion Industry Workshop – Panel Discussion

RAM Investigations

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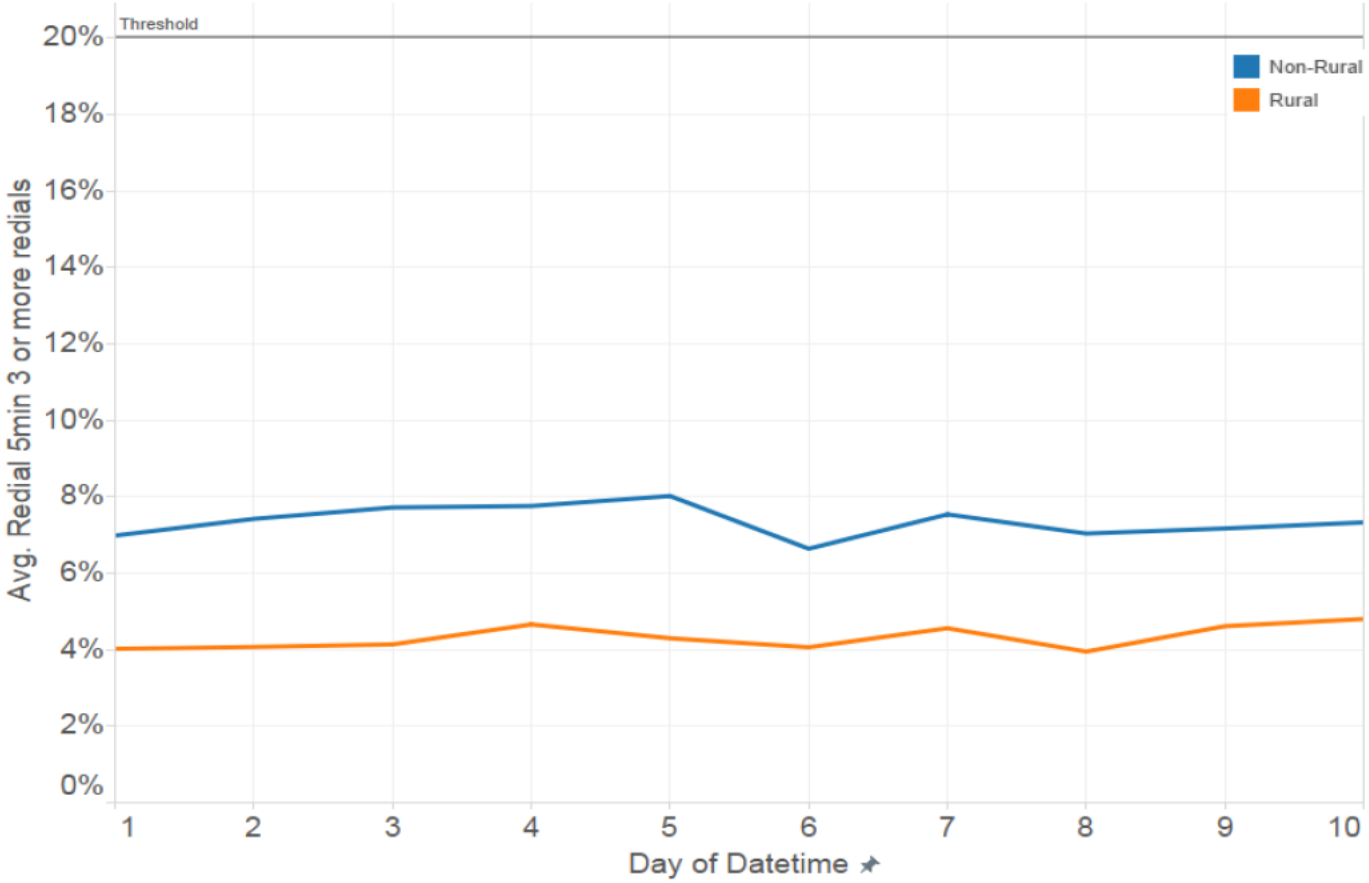
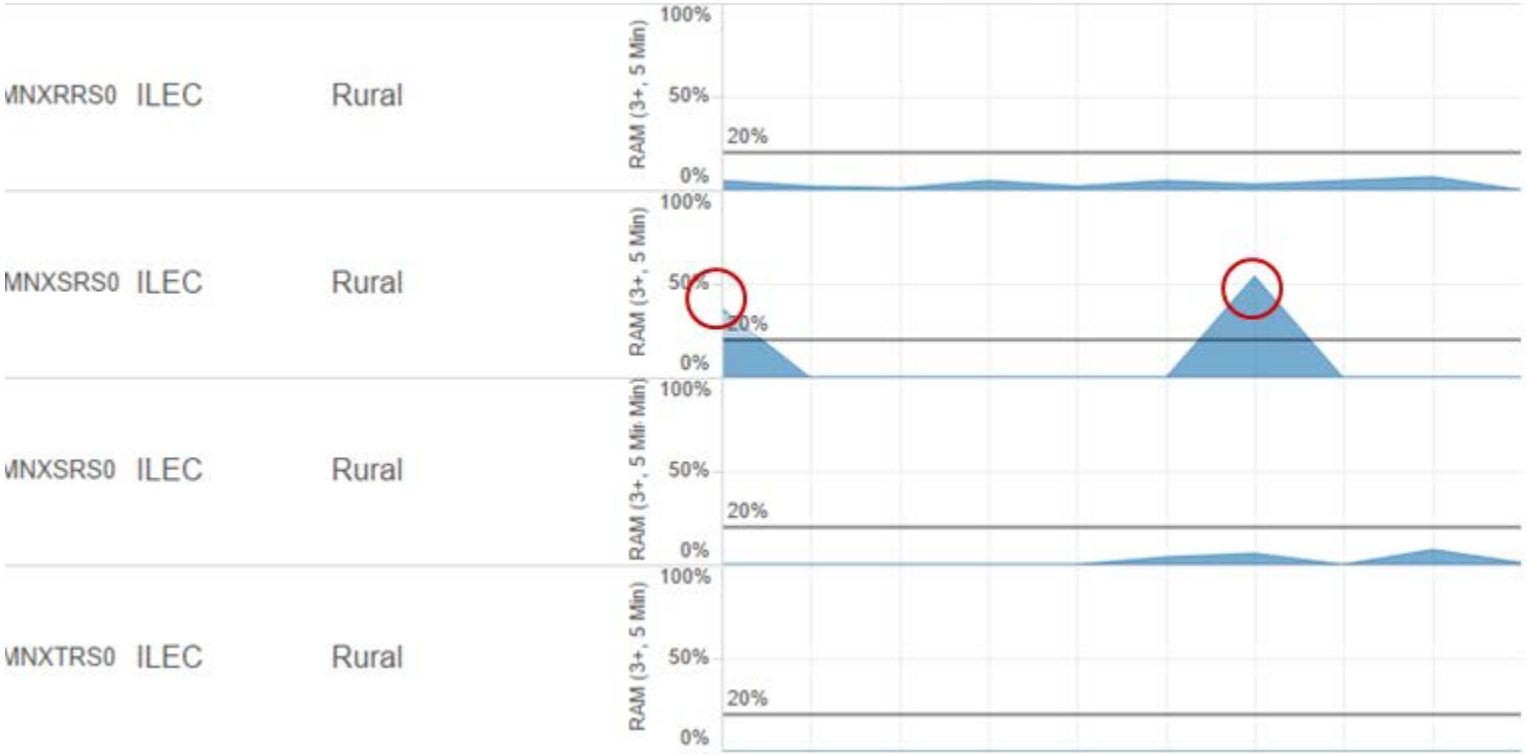


Rural Call Completion Industry Workshop – Panel Discussion

RAM Investigations

- **Currently focusing investigations on RAM spikes over 20% at the CLLI level.**



Rural Call Completion Industry Workshop – Panel Discussion

RAM Investigations, Current Findings

- Too soon to draw conclusions on merits of RAM
- Data sample has not been statistically validated

- **Examples of findings**
  - Re-dials on user-busy
  - End office/customer outages/equipment issues
  - Single from/to combinations (e.g., fax machine retries)
  - Mass call events (radio station contests)
  - Auto-dialer retries (still some auto-dialer traffic in the sample)

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RAM Investigations: Potential Enhancements to Metric

- **Unassigned Numbers**: Exclude any CALLED number that received a RWC 1 in the most-recent data sample.
- **Autodialers**: Exclude any CALLING number for which 50% or more of its calls were to unassigned numbers.
- **Machine Retries**: Do not count re-attempts within 3 seconds.
- **Single from/to number combinations**: Filter out RAM spikes resulting from issues between a single pair.
- **RWC 17**: Filter out retries to RWC 17, User Busy
- **Timing**: Investigate based on deviation from trend, not objective spikes.

Trade off: Increased Complexity / Fewer False Positives

Rural Call Completion Industry Workshop – Panel Discussion

Response to Complaints

- **Verizon receives complaints related to rural call completion through multiple channels.**
  - FCC (Consumer, wireline, and enforcement Bureaus)
  - RLEC hotline (dedicated toll-free number for carriers established in 2011)
  - Customers (voice customer complaints are automatically filtered for potential rural call completion issues)
    - Consumers (Wireless & Wireline)
    - Wholesale
    - Business

Rural Call Completion Industry Workshop – Panel Discussion

Response to Complaints: RLEC hotline (dedicated toll-free number for carriers established in 2011)

- Verizon RLEC hotline: 800-285-3776
- Dedicated, toll-free number that rural local exchange carriers can use to contact Verizon for assistance in trouble-shooting and remediating call completion issues involving Verizon customers.
- More information at: http://www.verizon.com/about/rural-call-testing

Rural Call Completion Industry Workshop – Panel Discussion

Complaint Investigations

- Timely, detailed complaints, with engagement from required parties can be useful in identifying and systemic call-failure drivers.
- Many issues are intermittent or transitory; resolve without intervention.
  - Inherent aspect of PSTN.
  - Acceptance of “no trouble found” as root cause.
  - Can lead to under-reporting.

Results of Academic Research

Rural Carrier Perspective

Open Discussion / Q&A

Closing Remarks

Thank you.

verizon